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PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

VOL. XLIV—No. 6

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FOUNDED
1852

August, 1918

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OF

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(INSTITUTED 1852)

VOL. XLIV—No. 6

AUGUST, 1918

Edited by the Secretary, under the direction of the Committee on Publications.

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NEW YORK 1918

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American Society of Civil Engineers

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GEORGE S. WEBSTER	JOHN F. COLEMAN

Secretary, CHARLES WARREN HUNT

Treasurer, GEORGE W. TILLSON

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Term expires January, 1919:	*Term expires January, 1920:*	*Term expires January, 1921:*
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HUNTER McDONALD
CHARLES D. MARX
CLEMENS HERSCHEL
GEORGE H. PEGRAM

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GEORGE W. TILLSON
EDWIN DURYEA

Special Committees

ON ENGINEERING EDUCATION: Desmond FitzGerald, Onward Bates, D. W. Mead.

TO CODIFY PRESENT PRACTICE ON THE BEARING VALUE OF SOILS FOR FOUNDATIONS, ETC.: Robert A. Cummings, Edwin Duryea, E. G. Haines, Allen Hazen, James C. Meem, Walter J. Douglas.

ON THE REGULATION OF WATER RIGHTS: F. H. Newell, W. C. Hoad, John H. Lewis.

TO REPORT ON STRESSES IN RAILROAD TRACK: A. N. Talbot, A. S. Baldwin, G. H. Bremner, John Brunner, W. J. Burton, Charles S. Churchill, W. C. Cushing, Robert W. Hunt, George W. Kittredge, Paul M. LaBach, C. G. E. Larsson, G. J. Ray, Albert F. Reichmann, H. R. Safford, F. E. Turneaure, J. E. Willoughby.

◆

The Reading Room of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

HEADQUARTERS OF THE SOCIETY—33 WEST THIRTY-NINTH STREET, NEW YORK.

TELEPHONE NUMBER....................4600 Vanderbilt.
CABLE ADDRESS......................."Ceas, New York."

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* Director William R. Hill died June 16th, 1918.

Vol. XLIV. AUGUST, 1918. No. 6.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PROCEEDINGS

This Society is not responsible for any statement made or opinion expressed in its publications.

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MINUTES OF MEETINGS

OF THE SOCIETY

May 15th, 1918.—The meeting was called to order at 8.30 P. M.; T. Kennard Thomson, M. Am. Soc. C. E., in the chair; Chas. Warren Hunt, Secretary; and present also 54 members and 7 guests.

A paper by Vernon L. Sullivan, M. Am. Soc. C. E., entitled "Construction Methods Used in Building the Lower Reservoir Dam of the Balmorhea Project", was presented by the Secretary and discussed by Mr. T. Kennard Thomson.

The Secretary read a letter which he had received from Sumner F. Shaw, M. Am. Soc. C. E., describing the recent earthquake in Guatemala, and also a second letter, on the same subject, supplied by A. W. Buel, M. Am. Soc. C. E. Mr. Shaw's letter was accompanied by a number of photographs from which lantern slides had been made and were shown. F. Lavis, M. Am. Soc. C. E., also exhibited a number of slides showing scenes, structures, etc., in Guatemala, and some interesting information was given by T. Howard Barnes, M. Am. Soc. C. E.

The Secretary announced the election of the following candidates on May 13th, 1918:

AS MEMBERS

JOHN CUMMINGS AUTEN, Wilmington, Del.
HENRY PERCY BORDEN, Montreal, Que., Canada
FREDERICK W. CARPENTER, Cornwall, N. Y.
FREDERICK ROBERT WHEELER CLEVERDON, New Rochelle, N. Y.
KARL DANIEL COWEN, Cleveland, Ohio
FRANK COLLINS EMERSON, Worland, Wyo.
JAMES HUGHES HEALD, Chicago, Ill.
CHARLES EPHRAIM McCOY, Charleston, W. Va.
FRANK COOK MOORE, New York City.

AS ASSOCIATE MEMBERS

STEPHEN CARTLAND BERRY, Belle Fourche, S. Dak.
BYRON GRAY BEST, Ironwood, Mich.
PARKER STANLEY BOOKWALTER, Dayton, Ohio
HOWARD CRAWFORD BOOZ, Winfield, N. Y.
RICHARD CHEETHAM BURTON, Guatemala, Guatemala
ROGELIO LILO CAPESTANY, San Juan, Porto Rico
STANLEY ALBA CHAPMAN, Washington, D. C.
GLENVILLE ARTHUR COLLINS, Seattle, Wash.
CLARKE COPELAND COTTRELL, Carson City, Nev.
MAURICE ALDEN COURTNEY, Tucson, Ariz.
BERNARD LEE CRENSHAW, Toccoa, Ga.
JOHN WILLIAM DALY, New York City
JOSEPH HOLMES LEE DODD, Kingston, Jamaica
THOMAS PENGELLY ELLIS, San Diego, Cal.
ARTHUR MAXWELL FIELD, Winchester, Va.
MARK WILLIAM FITZPATRICK, Toccoa, Ga.
JOHN CLAIR FOWLER, Spokane, Wash.
GEORGE ALBERT GEIB, St. Paul, Minn.
ANSON JOHN GERNER, Provo, Utah
THOMAS FENNER GIBSON, Washington, D. C.
ERNEST HENRY HARDER, Newark, N. J.
REUBEN HAYES, Washington, D. C.
WYATT CEPHAS HEDRICK, Dallas, Tex.
WILLIAM JAMES HOWARD, Kansas City, Mo.
HARLAND MARION HOYT, Lewiston, Idaho

George Alfred Hughes, Brooklyn, N. Y.
George Paxson Jones, Roanoke, Va.
Luther Hill Kirby, Alexandria, La.
Howard Robert Klepinger, Cleveland, Ohio
Otto Von Kruse, Niagara Falls, N. Y.
Walter Scott Lacher, La Grange, Ill.
Reuben Lawrence Larson, Peking, China
Paul Arthur Laurence, Minneapolis, Minn.
Verne Vere Long, Oklahoma City, Okla.
Charles Dubuisson Loveland, Pittsburgh, Pa.
James Alexander Duff Macbeth, Vancouver, B. C., Canada
Raymond Thomas Middleton, Washington, D. C.
Samuel Lawrence Milton, Roxbury, Mass.
Paul Willard Norton, Wellesley Hills, Mass.
Francis Chapman Packard, Beaumont, Tex.
Carl Gustav Paulsen, Atlanta, Ga.
Roy Albert Porterfield, Kansas City, Mo.
Samuel Shapiro, New York City
Alfred Kimberly Silvernail, Utica, N. Y.
Merton Rogers Sumner, Wilmington, Del.
Edgar Allchin Van Deusen, Charlotte, N. C.
Harry Draper Winsor, Westerleigh, N. Y.
Earl Belmont Woodin, Ambridge, Pa.
Earl Alderfer Zeisloft, Akron, Ohio

As Associates

James Ten Broeck Bowles, Washington, D. C.

As Juniors

Leslie Standish Hall, Oakland, Cal.
Clements McMullen, San Antonio, Tex.
James Blaine Newman, Cambridge, Mass.
Alfred Salem Niles, Jr., Cambridge, Mass.

The Secretary announced the transfer of the following candidates on May 13th, 1918:

From Associate Member to Member

Albert August Aegerter, St. Louis, Mo.
Stafford Xavier Comber, Georgetown, British Guiana
Meyer Davis, San Francisco, Cal.
Roy Cordis Hardman, Balboa Heights, Canal Zone, Panama
Charles Adams Hunt, Brooklyn, N. Y.
Maro Johnson, Chicago, Ill.

WESLEY EUGENE KING, St. Paul, Minn.
ROBERT HILEMAN LEE, Cumberland, Md.
LEONARD LUNDGREN, Am. Exp. Forces, France
WINFRED LEON MILNER, Potosi, Bolivia
JOHN HAYS MYERS, White Plains, N. Y.
JOHN ROBERT NICHOLS, Cambridge, Mass.
JOHN CLINTON PRIOR, Columbus, Ohio

FROM JUNIOR TO ASSOCIATE MEMBER

HAROLD WALLACE BAKER, Rochester, N. Y.
RAYMOND BOOTH, New York City
ALFRED MICHAEL DANZILLI, Pittsburgh, Pa.
REX EDWARD EDGECOMB, Philadelphia, Pa.
HENRY WILLIAM ENGLISH, Cape Girardeau, Mo.
PHILIP AUGUSTUS FRANKLIN, Seattle, Wash.
HAROLD WILEY GRISWOLD, Portsmouth, Va.
GEORGE WILLIAM HAWLEY, Berkeley, Cal.
RALPH WILLIAM HAZEN, Edgewater, N. J.
PAUL SIDNEY JONES, San Francisco, Cal.
ALBERT PREISACH LEARNED, Chickamauga Park, Ga.
FLOYD AUGUST NAGLER, Waco, Tex.
ELBERT HUME REIDPATH, Buffalo, N. Y.
GEORGE HUTZE RUHLING, Flint, Mich.
DANIEL HENRY SEAMAN, Newark, N. J.
GEORGE WILLIAM STEPHENS, JR., Roland Park, Md.
SETH MARTIN TIMBERLAKE, Brooklyn, N. Y.
ELLWOOD COGGESHALL WILDER, New Haven, Conn.

Adjourned.

June 5th, 1918.—The meeting was called to order at 8:30 P. M.; Vice-President Nelson P. Lewis in the chair; Chas. Warren Hunt, Secretary; and present, also, 103 members and 14 guests.

A paper by L. R. Jorgensen, M. Am. Soc. C. E., entitled "Improving Arch Action in Arch Dams", was presented by William P. Creager, M. Am. Soc. C. E., and a communication on the subject from S. H. Woodard, M. Am. Soc. C. E., was read by the Secretary.

Mr. W. H. Blood, Jr., presented a very timely and interesting address on "Hog Island, the Greatest Shipyard in the World", illustrating his remarks with lantern slides. A unanimous vote of thanks was tendered to Mr. Blood.

The Secretary announced the following deaths:

HERBERT JAMES CHAMBERS, of New York City, elected Associate Member, November 5th, 1902; Member, January 3d, 1911; died May 20th, 1918.

ALFRED BOARDMAN MAYHEW, of Dayton, Ohio, elected Associate Member, November 8th, 1909; Member, January 18th, 1916; died May 12th, 1918.

CLARENCE RUFUS NEHER, of Buffalo, N. Y., elected Member, June 4th, 1902; died May 12th, 1918.

HARRIS DANIEL BUCKWALTER, Capt., Engr. R. C., Am. Exp. Forces, of Royersford, Pa., elected Associate Member, May 31st, 1916; killed in action in France, May 12th, 1918.

JAMES GORDON GOODFELLOW, Capt., R. E., 416th Field Co., B. E. F., of Edinburgh, Scotland, elected Junior, September 3d, 1913; Associate Member, October 9th, 1917; killed in action in France, March 23d, 1918.

Adjourned.

ELECTIONS AND TRANSFERS BY THE BOARD OF DIRECTION, JUNE 18th-19th, 1918.

ELECTED AS MEMBERS

CHARLES BROSSMANN, Indianapolis, Ind.
WILLIAM HARPER CHORLTON, New York City
THOMAS HENDRICKS DAVID, Indianapolis, Ind.
JOHN EDWARD HAYES, Denver, Colo.
HENRY CHANDLER ROBBINS, Boston, Mass.
ELMORE MARCELLUS ROHRBOUGH, Omaha, Nebr.
BERNHARD ALEXANDER SMITH, Melbourne, Victoria, Australia

ELECTED AS ASSOCIATE MEMBERS

FRANK KARR ASHWORTH, Miami, Fla.
CARROLL GUERNSEY BENNETT, Springfield, Ill.
JAMES ARCHIBALD CAMPBELL, JR., Topeka, Kans.
JOHN CHAUNCEY CHILDS, Philadelphia, Pa.
JOHN LYELL CLARKE, Richmond, Va.
JOHN THOMAS CRAVEN, St. Louis, Mo.
LOUIS ELMER DIERKS, Oak Park, Ill.
CLAUDE ORVILLE DIFFENDERFER, Camp Dodge, Iowa
LOUIS REA DOUGLASS, Trinidad, Colo.
PETER STAUB DOW, Hanover, N. H.
ROBERT FRANCIS DURYEA, San Francisco, Cal.
EUGENE COURTLANDT EATON, Lindsay, Cal.
OSCAR ROELIF ELTING, Akron, Ohio
WARD BENJAMIN ESTERLY, San Francisco, Cal.
JOHN LAVERN FRANZEN, Medicine Hat, Alberta, Canada
ALBERT STEVENS FRY, Memphis, Tenn.
RALPH LEMAN GARLINGHOUSE, Briceburg, Cal.
ALLEN STACY HADLEY, Kansas City, Mo.
ADOLF HINRICHS, Detroit, Mich.

Herman David Hirsch, New York City
Albert Huber, Jr., San Francisco, Cal.
Roy Husselman, Lakewood, Ohio
George Wiley Jones, Los Angeles, Cal.
Samuel Thomas Jones, Jr., Construction, N. C.
Luther Larue, Akron, Ohio
Walter John Lehner, Mt. Clemens, Mich.
Curtis John McCoy, Wichita, Kans.
Thomas Franklin Maloy, Landisburg, W. Va.
Theodore Robert Mini, Visalia, Cal.
Charles Halvatious Mottier, Chicago, Ill.
Charles Sabin Nichols, Ames, Iowa
Lewis Magnus Norelius, Sioux Falls, S. Dak.
Roger Wolcott Olmsted, Manteca, Cal.
George Paaswell, New York City
John Peterson, Enderlin, N. Dak.
Walter Belleville Phillips, Dayton, Ohio
Wilmer Houston Potts, Copperhill, Tenn.
Ralph Sawyer Proctor, Chicago, Ill.
Dwight Raymond Redman, North Yakima, Wash.
Roger Rockford Robertson, Grand Junction, Colo.
Herbert Arlon Rowland, McPherson, Kans.
Alexander Charles Schilling, South Hill, Va.
Carl Cris Seeger, Cuyamel, Honduras
Clyde John Seymour, Nanaimo, B. C., Canada
Russell Elstner Snowden, Goldsboro, N. C.
Harold Tattersall, Jersey City, N. J.
Tulloch McCosh Townsend, Schenectady, N. Y.
James Arthur Trudeau, Newman, Cal.
William Baxter Vestal, Anaconda, Mont.
Russell Dutton Welsh, Camp Lewis, Wash.
Walter Hall Wheeler, Minneapolis, Minn.
Charles Clinton Young, Oakland, Cal.

Elected as Associates

John Irving Spooner, Jersey City, N. J.

Elected as Juniors

Maurice Foster Chadwick, Tulsa, Okla.
Frank Lyman Fuller, Brooklyn, N. Y.
Edgar Nathan Goldstine, Cambridge, Mass.
Frank La Salle Grady, Poughkeepsie, N. Y.
Howard Whipple Green, Ancon, Canal Zone, Panama
Eric Vail Howell, Ithaca, N. Y.
Abraham Harry Okun, New York City

TRANSFERRED FROM ASSOCIATE MEMBER TO MEMBER

ARTHUR ADAMS, Brooklyn, N. Y.
GEORGE EVERETT BAKER, Whitehall, Mont.
EUGENE HARRY BRUNTLETT, Blue Island, Ill.
ELBERT MILAM CHANDLER, Yakima, Wash.
THOMAS REMINGTON HOLDEN DANIELS, Indianapolis, Ind.
CHARLES MOSS DAVIS, Fort Worth, Tex.
CHARLES EMERSON GREGORY, Mt. Kisco, N. Y.
HARRY LEWIS HAEHL, San Francisco, Cal.
GILBERT GARFIELD JACOBOSKY, Camp Custer, Mich.
EDWARD GEORGE WALKER, London, S. W., England
WADE CLARENCE WEST, Manila, Philippine Islands

TRANSFERRED FROM ASSOCIATE TO MEMPER

ROBERT BRECK MORAN, Los Angeles, Cal.

TRANSFERRED FROM JUNIOR TO ASSOCIATE MEMBER

MERTON CLYDE COLLINS, Manila, Philippine Islands
GERALD CHAPMAN FITZGERALD, Camp Fremont, Cal.
THOMAS CAROL HIGGINS, Norfolk, Va.
VICTOR JOHN MILKOWSKI, Am. Exp. Forces, France
EDWARD ASHTON WARD, Newark, N. J.

OF THE BOARD OF DIRECTION

(Abstract)

June 18th, 1918.—The Board met at 10 A. M.; President Talbot in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Alvord, Davis, Duryea, Fay, Flinn, Hawgood, Herschel, A. M. Hunt, Khuen, Noble, Pegram, Rights, Wagner, and Webster.

The following report on a plan by which officers of the Society would visit Local Associations was adopted by the Board, and the Secretary was instructed to forward a copy to each of the Local Associations:

"JUNE 18, 1918.

"TO THE BOARD OF DIRECTION,
AMERICAN SOCIETY OF CIVIL ENGINEERS:

"Your Committee appointed to evolve a plan by which the Director in each District or the Secretary or other officer of the Society, should visit, from time to time, the various Local Organizations, begs to report that it has considered the matter, and while believing that the closer touch between the Board and the Local Associations which is desired, can in no way be better secured than by visits at least once a year by the Director for that district or other officer of the Society, it realizes that the districts are in some cases large, and except District No. 1, have but one Director and the number of Local Associations is constantly increasing, so that mandatory action or the establishment of a custom that might impose burdensome duties should be avoided, while at the same time, encouragement should be given to the making of such visits.

"Your Committee recommends the adoption of the following:

"*Resolved:* That the President and Secretary of the Society, and the Director in each District, shall arrange as far as possible with each Local Association for a visit each year either by the Director in that District, or the President, or Secretary, or other officer of the Society, and that the expenses incurred in making such visit upon the invitation of a Local Association shall be paid by the Society.

"Geo. H. Pegram
"Samuel T. Wagner
"A. M. Hunt
"*Committee.*"

The resignation of A. J. Himes as representative of District No. 6 on the Nominating Committee was accepted, and George H. Tinker was appointed to fill the vacancy, Mr. Tinker having received the endorsement of the Cleveland and Pittsburgh Associations of Members of the Society.

The Secretary reported on several matters in connection with leasing the Society House on Fifty-seventh Street, possible alterations, etc., and, after discussion, the whole matter was referred to the Executive Committee with power.

A Committee to Recommend the Award of Prizes for 1918 was appointed as follows: Messrs. W. C. Hoad, Peter Mogensen, and H. R. Safford.

S. H. Woodard was appointed as the additional representative of the Society on Engineering Foundation.

The Secretary reported that Professor H. W. Hayward had attended the Spring Convention of the American Society of Mechanical Engineers as the Society's representative at the public hearing on the Report of the Screw Thread Tolerance Committee of that Society, at Worcester, Mass., June 4th to 7th, 1918.

The Secretary was instructed to forward a copy of a resolution, adopted by the Detroit Section of the American Society of Mechanical Engineers with regard to a conference of Industrial Directors and heads of technical schools and colleges to arrange for special courses of instruction for women, and for publicity of the matter, to each of the Local Associations, asking them to do what they can in the matter.

At the request of Henry M. Howe, Chairman, Division of Engineering, National Research Council, that the Board appoint a member of the Committee on Engineering, Vice-President George S. Webster was appointed.

The Secretary reported that a Joint Constitutional Conference had been proposed by the Cleveland Association of Members; he also reported the action taken by several other Local Associations in regard to the matter, and also a request from two Associations that a proportional part of the annual dues be remitted to the management of each Local Association for the purpose of assisting its activities.

A preamble and resolutions were adopted by the Board providing for the appointment of a Committee on Development of the American Society of Civil Engineers.*

The Board decided to close the Reading Room of the Society in the evenings during July and August.

Ballots for membership were canvassed, resulting in the election of 7 Members, 52 Associate Members, 1 Associate, 7 Juniors, and the transfer of 5 Juniors to the grade of Associate Member.

Eleven Associate Members and 1 Associate were transferred to the grade of Member.

Applications were considered and other routine business transacted.

Adjourned.

June 19th, 1918.—The Board met at 1.15 P. M., immediately after the adjournment of the meeting of the Membership Committee; President Talbot in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Alvord, Duryea, Fay, Flinn, Hawgood, Humphreys, Khuen, Lewis, and Rights.

The Roll of Honor published each month in *Proceedings* was considered, and it was decided that the names of those who have lost their lives in the service be printed at the head of the present Roll of Honor in distinctive type.

A report from the Membership Committee was received and acted upon.

The Secretary reported the death, on June 16th, 1918, of Director William R. Hill, and, on motion, the Secretary was requested to prepare a proper Minute on the death of Mr. Hill for insertion in the Minutes of the next meeting.

Adjourned.

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* See page 604.

SOCIETY ITEMS OF INTEREST

Committee on Development of the American Society of Civil Engineers

PREAMBLE AND RESOLUTIONS ADOPTED BY THE BOARD OF DIRECTION, JUNE 18TH, 1918.

"The development and application of the sciences in recent decades have caused profound changes in the social and industrial relationships of all peoples.

"The Engineer has been a leader in this progress.

"Sociological and economic conditions are in a state of flux and are leading to new alinements of the elements of society.

"These new conditions are affecting deeply the profession of engineering in its services to society, in its varied relationships to communities and nations, and in its internal organization.

"A broad survey of the functions and purposes of the American Society of Civil Engineers is needed in order that an intelligent and effective readjustment may be accomplished so that the Society may take its proper place in the larger sphere of influence and usefulness now opening to the Profession.

"Such a survey and readjustment can be accomplished successfully only with the aid of the membership throughout the country.

"Any steps toward changes in organization must lead to a revision of the Constitution of the Society, which has not been materially modified for many years, during which the Society has grown rapidly and has established 22 Local Associations of Members.

"The Constitution should be revised only after securing the views of the membership of the Society as to what its purposes and activities should be and as to the instrumentalities through which these purposes and activities should be carried out.

"Any changes in organization must take into account all the conditions above indicated, and also the relationship of the American Society of Civil Engineers to other engineering organizations and to the public.

"Therefore:

"*Resolved,* that a Committee be created to report on the purposes, field of work, scope of activity and usefulness, organization, and methods of work of the American Society of Civil Engineers, and to make recommendations concerning these matters; the Committee to consist of one member chosen by each Local Association of Members, and seven members at large appointed by the President.

"*Resolved,* that the President be instructed to select from this Committee an executive committee of not less than five nor more than nine members, and to appoint the chairman of this executive committee, who shall also be the chairman of the general committee.

"*Resolved,* that the President be instructed to prepare a precept for the general guidance of this Committee.

"*Resolved,* that this Committee be requested to present to the Board of Direction a preliminary report, not later than November 1st, 1918, so that it may be printed and distributed to the membership in advance of the Annual Meeting in January, 1919, at which meeting it will be presented for discussion."

Engineer Officers Wanted by the War Department

During July, 1918, circulars and application blanks relative to commissions in the Engineer Reserve Corps were forwarded to all members of this Society between the ages of 32 and 42.

As the requisite number of officers has not yet been secured, it has seemed advisable to bring the matter again to the attention of the membership, and urge all those who are in a position to accept commissions, as Captain or First Lieutenant, to offer their services to the Government.

Applications for examination must be made on the proper blank (which may be obtained from the Office of the Chief of Engineers, or from the Secretary of this Society), and must be forwarded to the Chief of Engineers at Washington, D. C.

The qualifications of the applicants will be considered in the Office of the Chief of Engineers, and those selected will be notified when to appear at the designated place for the professional and physical examination; this will be conducted by a Board of Engineers sent out from Washington, D. C.

The Examining Board will only receive applications for appointment in the grades of first lieutenant and captain, and only those applicants meeting the following requirements will be considered, viz:

> Age limits: For the grade of first lieutenant—32 to 36 years; for captain—36 to 42. These limits may be slightly increased or decreased in special cases, except that no one who is within the draft age will be considered.
>
> Applicants must be engaged in the active practice of the engineering profession, in one of its various branches, and be in good physical condition.
>
> Professional qualifications and experience: No set rules have been established. An applicant's fitness for commission will be determined by the Examining Board.
>
> All applicants must be citizens of the United States.
>
> No applications will be received from any one now in Government service.
>
> Applications will not be considered from any one born in a country with which the United States is at war, or born in a country allied with a country with which the United States is at war, even though he be a naturalized citizen of this country.

All applicants accepted by the Examining Board will be commissioned within ten days or two weeks, and, within a few days thereafter, will receive orders to report at an Engineer Officers' Training Camp, either at Camp Lee, Petersburg, Va., or at Camp Humphreys, Va., near Washington, where they will be given a course in military training previous to being assigned to duty with Engineer troops.

Applicants must understand, however, that it is required of an Engineer officer that he not only be professionally qualified, but must also possess the requisite qualities of leadership and temperament to fit him for the command of troops. The case of each student officer will be carefully considered by a Board of Officers of the Corps of Engineers of the Regular Army, just previous to the completion of his course of instruction (unless circumstances necessitate an earlier consideration), and, as a result of the showing which he has made, he will either be allowed to retain his commission, or will be honorably discharged.

The Government will allow traveling expenses at the rate of seven cents per mile to applicants who may be commissioned, and they will also receive, while in the training camp, the regular pay of an officer of their rank.

Applicants who receive commissions and are ordered to camp, should provide themselves only with the usual Engineer officer's uniform, cap, puttees, and tan shoes. For training purposes, the camp authorities will issue them, on memorandum receipt, equipment, and will provide the necessary sleeping accommodations.

The only manner in which men between 31 and 42 years of age may be certified to attend an Engineer Officers' Training Camp is to be ordered there for duty as students after having been commissioned in the Engineer Reserve Corps.

The Board of Examiners will hold examinations in the following cities:

Washington, D. C.
Philadelphia, Pa.
New York, N. Y.
Boston, Mass.
Albany, N. Y.
Buffalo, N. Y.
Cleveland, Ohio
Detroit, Mich.
Pittsburgh, Pa.
Youngstown, Ohio
Cincinnati, Ohio
Louisville, Ky.
Chicago, Ill.
Indianapolis, Ind.
St. Louis, Mo.
Kansas City, Mo.
St. Paul, Minn.
Denver, Colo.
Salt Lake City, Utah
Butte, Mont.
Seattle, Wash.
Portland, Ore.
San Francisco, Cal.
Los Angeles, Cal.
Deming, N. Mex.
Dallas, Tex.
New Orleans, La.
Memphis, Tenn.
Nashville, Tenn.
Birmingham, Ala.
Atlanta, Ga.
Charleston, S. C.
Richmond, Va.

Recent Gifts to the Engineering Societies Library

During the past twenty years the Westinghouse Electric and Manufacturing Company and the General Electric Company have collected a valuable library of about nine thousand volumes on electricity. The collection was intended especially for use in patent searches and is particularly rich in patent material. Files of all the principal patents relating to electric light and power issued by America, England, France, and Germany are included, together with copies of the patents owned or controlled by the two companies. Another feature, and one of unusual value, is a series of volumes containing the records of the important adjudicated patent causes of these companies and their predecessors during the past twenty-five years, and forming a storehouse of electrical history. There are also files of about one hundred electrical periodicals.

It is a pleasure to announce that this collection has now been presented by the owners to the Engineering Societies Library. This gift, which was arranged through Mr. Charles A. Terry, Vice-President, Westinghouse Electric and Manufacturing Company, and Mr. Charles Neave, Counsel, General Electric Company, was made with the thought that the collection would be useful to many engineers if housed in an easily accessible location. It is an unusually valuable accession, for which the Library authorities are deeply grateful.

The books have been transferred to the Engineering Societies Library, where they may now be consulted.

During April, 1918, Mr. Jesse M. Smith, presented nearly four hundred volumes and pamphlets selected from his private library, consisting of engineering periodicals, and of records of patent causes with which Mr. Smith has been connected.

Mr. Putnam A. Bates has presented large portfolios, containing a set of drawings for the new fire alarm system of New York City, which will prove interesting to engineers.

F. H. Newell, M. Am. Soc. C. E., has collected and presented a number of interesting publications relating to the Council of Engineering Societies on National Public Works, which was active in attempting to reform the policy governing the conduct of public works in this country during the Eighties.

Space forbids the mention of many other gifts, but these, in nearly every case, have been of decided value to the Library, and have been appreciated also as evidence of friendly interest in its success. It is hoped that every member will bear the needs of the Library in mind and present from time to time any new or old engineering material which he can spare. General co-operation will bring to its shelves much scattered material which cannot be obtained in any other way.

Duluth Engineers at "Get-Together" Dinner

The engineers of Duluth, Minn., took the first steps toward the formation of a Duluth Engineers' Club, by meeting at a "get-together" dinner during the evening of May 20th, 1918, at the Kitchi Gammi Club.

At present, Duluth has no club embracing all engineers. During the past there have been informal committees for the entertainment of visiting engineers, and about thirty years ago a movement to organize was initiated, but not completed. Duluth has many other representative clubs and, the civic spirit being strongly developed, ranks high among other cities of the country for its activities and discussions of public questions. The environment is splendid for the growth of an engineers' organization.

The movement for the formation of a club has been under consideration for about six years, but it lacked enthusiasm until the successful launching and maintenance of the Duluth Association of Members of the American Society of Civil Engineers during the last three and a half years showed the possibilities.

There are within reasonable distance of Duluth, more than one hundred members of the four large National engineering societies, a number of members of the lesser engineering societies, and many non-members. Until the Duluth Association of Civil Engineers was organized, these engineers had no common ground of meeting, no means to render their united thought effective on questions concerning the welfare of the Profession, or to promote the civic activities of their skill. A force representing education, experience, and high ideals lay dormant, ignored, and unused for the common good.

The Duluth Association of Civil Engineers, however, can and does represent only a small part of the whole body of trained technical men. Something bigger and broader is needed in Duluth. With this view in the minds of the Civil Engineers, the Duluth Association, in March, 1917, appointed Messrs. W. H. Hoyt, W. B. Patton, and W. H. Woodbury, as a committee to develop a plan for a Duluth Engineers' Club. This Committee has studied the situation carefully, and is now ready to help in the development.

Its first important move was the call sent out for the "get-together" dinner to all members of the four National engineering societies living within suitable distance of Duluth to attend and take part in the discussion. About seventy engineers were present, and took an active interest in the movement. Favorable responses were received from others who could not be present during the evening. The Committee prepared an excellent programme of talks and lantern-slide pictures.

F. E. House, President of the Duluth and Iron Range Railroad, and retiring President of the Duluth Association of Members of the American Society of Civil Engineers, acted as toastmaster. In opening the programme, he outlined briefly the objects of the meeting, and called attention to the importance of the engineer in all lines of activity of the war and the splendid qualities of American engineers in France, who could fight as well as work. He stated that "steps have already been taken toward the formation of an engineering club, and it is for the assembly here to-night to say whether they will be carried out."

Mr. W. H. Woodbury was called on to outline the plan. Three objects of the club were given by him; first, professional; second, social; third, civic. Four plans of membership have been considered: First, to have an organization for all professional engineers, junior engineers, and associates, with different status for each; second, an organization made up of members of the four National societies; third, an organization of members and a limited number of associates; and fourth, professional engineers only, all on an equal standing.

Mr. W. H. Hoyt reported preliminary suggestions for arranging a home for the club.

A resolution was offered by Mr. T. W. Hugo, Emeritus Member of the American Society of Mechanical Engineers, that it was the sense of those at the gathering that steps should be taken to form an engineers' club in Duluth and that a committee be appointed to develop the plan. This was passed unanimously. Mr. House appointed a committee of eight representative engineers as follows: American Institute of Electrical Engineers: W. N. Ryerson, Chairman, Walter F. Schwedes; American Institute of Mining Engineers: Edwin J. Collins, Walter G. Swart; American Society of Mechanical Engineers: Oscar B. Bjorge, W. H. Gallagher; American Society of Civil Engineers: W. H. Hoyt, W. H. Woodbury.

It is hoped that this Committee will make such progress that another meeting can be called in June to put its decisions into effect.

Although it is realized that engineers are busy with war activities and responsibilities, it is felt here that this is the time to unite the whole Profession in one effective body, promoting its interests and welfare, and rendering service to the community. War has shown the great responsibility and opportunity of engineers to direct and do the work of the nation. It has emphasized the lack of complete unity of the Profession both locally and nationally.

The progress made by the National engineering societies in unifying their efforts toward securing the proper recognition and employment of their talents to the fullest degree, has been reflected by many cities in the formation of strong, well-conceived engineers' clubs which have even advanced further in their work for the Profession.

Duluth has a large list of engineers of high standing as individuals, and the leaders of the movement for a club are very optimistic of the strength and success possible.

The programme of the evening included addresses by men of nation-wide reputation in engineering fields.

Dean John Allen, of the College of Engineering of the University of Minnesota, talked of the heavy call for engineers, the depletion of the numbers of students attending the universities, and the drawing away of their instructors. He urged on the engineers present the necessity of encouraging young men to take up engineering studies in order that deficiencies in the number of engineers may be prevented, quoting from President Wilson's address to educators, "every parent is urged to keep his children in school and college, no matter what sacrifice is necessary at home." The country is facing a serious problem, in the shortage of engineers, and the Government will soon be forced to take drastic action.

Mr. Calvin W. Rice, National Secretary of the American Society of Mechanical Engineers, brought greetings from his Society to the engineers of Duluth, and also read a telegram from the American Institute of Electrical Engineers expressing good will for the organization of a club and hoping that its members would take an active part as well as form a local branch of the Institute. Mr. Rice's talk was full of eloquent appeal to the engineers to take up the work and place on its banner the idea of high service for the general welfare of the Commonwealth and Profession. He set forth that it is for the engineers of America to give to the service the loftiest expression of its objects in organizing any technical society.

Mr. Kirby L. Strickland, Erecting Manager of the American Bridge Company at Chicago, Ill., gave a talk on the Union Pacific Railway Company's new bridge over the Missouri River at Omaha, Nebr., illustrated with lantern slides.

Mr. Richard Khuen, Jr., member of the Board of Direction of the American Society of Civil Engineers, who had a hand in building the famous "Hell Gate" Bridge at New York City, described the work, and, with lantern slides, illustrated the construction in a very interesting manner. A moving picture film was used to show how the job was arranged.

Engineering Congress, Java, 1919

The following letter relative to an Engineering Congress to be held in Java in 1919, under the auspices of the Royal Netherlands Institute of Engineers, together with a description of the Dutch East Indies and a statement of the scope of the Congress, is published here for the information of the membership:

"9 Highland Pl., Maplewood, N. J
"May 9th, 1918.

"Charles Warren Hunt, Esq.,
"Secretary, American Society of Civil Engineers,
"33 W. 39th St., New York City.

"Dear Sir: The Royal Netherlands Institute of Engineers are planning to have an engineering congress in Java sometime in 1919, in connection with which the interest of America, Australia, and Japan is solicited. The writer and Mr. Jhr. J. C. van Reygersberg Versluys, who recently passed through the States *en route* to Holland, have been asked to give publicity to this project.

"While the war will no doubt exert a curbing influence upon an undertaking of this nature, the fact that the Netherlands Indies is a land of wealth and opportunity and only awaits a return of more normal conditions before its industrial development will proceed with rapid strides, will, undoubtedly, make this congress of particular interest to engineers, manufacturers, and exporters.

"Anything you may be able to do to bring this matter to the attention of the members of the American Society of Civil Engineers and its affiliations, will be greatly appreciated.

"More definite information will be available at a later date. It is the present intention to have the more important proceedings printed in pamphlet form for distribution. Further inquiries may be made by communicating with the Royal Netherlands Institute of Engineers, East Indian Section, Batavia, Java.

"Yours very truly,

"FRANK B. DE LARA."

The Dutch East Indies.—The Dutch East Indies comprise the largest and most valuable islands of Malaysia, consisting of Java, Sumatra, the most of Borneo, Celebes, Moluccas, numerous smaller islands, and part of New Guinea. They cover an area of about 736 400 sq. miles, lying between latitudes N. 6 and S. 10, and spreading about 3 000 miles. The total population is about 47 000 000, of which Java, the most important of the group, with an area of 50 500 sq. miles, claims 37 000 000. This latter island has a length of about 650 miles and an average width of about 80, and has a broken volcanic range of mountains running through its length. It may be interesting to note that, with an area of about one-third that of California, it has a population twelve times greater.

Among the principal agricultural resources are sugar, of which 1 800 000 tons are exported every year; rubber, which has been developed since 1910, and which, in 1916, was exported to the amount of 30 000 tons, and is expected to reach 100 000 tons for 1920; tea, with an average annual export of 50 000 tons; copra; oil-producing plants; kapok; quinine, almost the entire production of the world; rice; tapioca; and tobacco, amounting to about 6 500 tons yearly, of which 25% is the well-known Sumatra leaf. Formerly, Java was famous for its production of fine coffee, but, some years ago, this culture suffered from the ravages of a very malignant blight, and is now produced only in small quantities, although a more sturdy plant, producing an inferior bean, is cultivated to some extent.

Although the mineral resources were not considered as being of particular importance up to a few years ago, more recent geological surveys and investigations augur a promising future. Coal production, amounting to 600 000 tons per year, has been equal to only about one-third of the local consumption, but the recent discovery of large fields, together with the success of governmental experiments in converting this coal into coke, will afford considerable encouragement to many industries. Large iron ore deposits have been discovered in Sumatra, Borneo, and the Celebes, and now that coke, which, in large quantities, formerly had to be imported, is obtainable locally, and as limestone is abundant, the erection of the first blast furnace and steel mill is expected immediately after the war. Valuable nickel deposits have also been found in the Celebes, which are expected soon to rank high among present producing fields. Petroleum production is already well established in the world's supply, and is controlled principally by the Royal Dutch Shell Company, the crude oil of the Sumatra fields yielding upward of 50% of gasoline.

Small water-power plants are numerous throughout the mountain regions of Java, and recent surveys, conducted by a special staff of Government engineers, have led to the planning of large hydraulic power projects which will be carried out after the war. The electrification of the railroads, and the production of electric power for industrial purposes, will be coincident with this development.

The railway system in Java is complete, with the exception of a few branch lines, but large districts in the other islands are still to be opened up by highways and railroads. Motor transportation is quite popular.

The most important shipping ports are Tandjong Priok (port for Batavia), Soerabaya, Semarang, and Tjilatjap, in Java; Macassar, in the Celebes; Balik Papan, in Borneo; Belawan-Deli, and Padang, in Sumatra. Although all these ports afford very good shipping facilities, at several of them improvements are under way which, when completed after the war, will make them modern in all respects.

The rivers throughout the islands are, in general, shallow, and not well adapted for transportation.

To the technically interested visitor are recommended inspection of the various agricultural industries; the petroleum industry in Sumatra and Borneo; the extensive irrigation systems in Java; the railways, which are typical of the 3 ft. 6-in. gauge system, developed to a high grade of efficiency; and the ambitious harbor improvements at present under development at Tandjong Priok and Soerabaya.

Among the subjects to be treated at the proposed Congress, the following may be of special interest:

A.—Harbors of the Netherlands Indies.—

1. Location.
2. Existing Harbors.
3. Construction.

4. Present and Proposed Development.
5. General Administration.
6. Financial Outlays and Returns.
7. Bonded Ports.
8. Reinforced Concrete in Harbor Works.
9. Dredging and Dredging Machinery.
10. Dry Docks.
11. Navigation Buoys and Beacons.

B.—Railways of the Netherlands Indies.—

1. Railway Systems.
2. Planning, Building, and Exploitation of Secondary Railways.
3. Railway Standardization.
4. Electrification.
5. Cog-Wheel Railways.
6. Reinforced Concrete Structures.
7. Terminals and Rights-of-Way in Cities.
8. Tariffs and Government Regulation.
9. Sinisoidical Wear of Electric Tram Line Rails.
10. Principal Railway Structures in the Netherlands Indies.
11. Signal Systems.
12. Rolling Stock.

C.—Water Supply, Irrigation, and Drainage.—

1. General Discussion of the Subject.
2. Organization and Control in the Netherlands Indies.
3. Organization and Control in the Philippines, Japan, British India, and the United States.
4. Details of Construction.
5. The Financing, Government Regulation, and Economics of Water Supply, Irrigation, and Drainage.
6. Sources and Systems of Water Supply.
7. Hydro-Geology.
8. Bacteriological and Chemical Properties of Water Supplies.
9. Consumption.
10. Description and History of, and Methods of Managing, Existing Systems.
11. Tropical Sewerage Systems.

D.—City Planning and Architecture Specialized for the Tropics.—

1. Inexpensive Houses.
2. The Modern Tropical House.
3. Earthquake-Proof Structures.
4. Sanitation of Tropical Communities.
5. Tropical Hospitals.

6. Town and City Planning in the Tropics.
7. Road Building, Maintenance, and Financing.
8. Motor Car and Truck Traffic.

E.—Industrial Activities and Opportunities in the Netherlands Indies.—

1. Opportunities to Open Up New Industries for the Manufacture of Textiles, Matches, Pottery, Glass, Fertilizers, Boxes, Barrels, and Bags.
2. Natural Products and Raw Materials of the Netherlands Indies Available for Industrial Purposes, such as Coal, Petroleum, Tin, Iron, Nickel, Vegetable Oils, Cotton, Ramie, Hemp, Kapok, Sisol, Jute, Rubber, and Sugar.
3. The Labor Question as a Factor in Industrial Development.
4. Hydro-Electric Power Development, Production, and Transmission.
5. Prospective Manufacture of Iron and Steel.
6. Electrically Operated Sugar Machinery.
7. Waste and By-Products of Sugar Manufacturing and Their Industrial Uses.
8. The Manufacture of White Sugar without Refining.
9. Co-Operative Central Bureaus of Efficiency in the Sugar Industry.
10. The Manufacture of Fertilizers.

The Duty of the Employer in the Reconstruction of the Crippled Soldier

The following article by Douglas C. McMurtrie, Director of the Red Cross Institute for Crippled and Disabled Men, New York City, is published for the information of the membership:

"We must count on the return from the front of thousands of crippled soldiers. We must plan to give them on their return the best possible chance for the future.

"Dependence cannot be placed on monetary compensation in the form of a pension, for in the past the pension system has proved a distinct failure in so far as constructive ends are involved. The pension has never been enough to support in decency the average disabled soldier, but it has been just large enough to act as an incentive to idleness and semi-dependence on relatives or friends.

"The only compensation of real value for physical disability is rehabilitation for self-support. Make a man again capable of earning his own living and the chief burden of his handicap drops away. Occupation is, further, the only means for making him happy and contented.

"Soon after the outbreak of hostilities the European countries began the establishment of vocational training schools for the rehabilitation of disabled soldiers. They had both the humanitarian aim of restoring crippled men to the greatest possible degree and the economic aim of sparing the community the burden of unproductivity on the part of thousands of its best citizens. The movement had its inception with Mayor Edouard Herriot of the City of Lyons, France, who found it difficult to reconcile the desperate need for labor in the factories and munition works while men who had lost an arm or a leg but were otherwise strong and well were idling their time in the public squares. He therefore induced the municipal council to open an industrial school for war cripples which has proved the example and inspiration for hundreds of similar schools since founded throughout France, Italy, Germany, Great Britain, and Canada.

"The disability of some crippled soldiers is no bar to returning to their former trade, but the injuries of many disqualify them from pursuing again their past occupation. The schools of training prepare these men for some work in which their physical handicap will not materially interfere with their production.

"The education of the adult is made up largely of his working experience. The groundwork of training in his past occupation must under no circumstances be abandoned. The new trade must be related to the former one or be, perhaps, an extension or specialization of it. For example, a man who had done manual work in the building trades may by instruction in architectural drafting and the interpretation of plans be fitted for a foreman's job, in which the lack of an arm would not prove of serious handicap. A trainman who had lost a leg might wisely be prepared as a telegrapher, so that he could go back to railroad work, with the practice of which he is already familiar.

"Whatever training is given must be thorough, for an adult cannot be sent out to employment on the same basis as a boy apprentice. He must be adequately prepared for the work he is to undertake.

"The one-armed soldier is equipped with working appliances which have supplanted the old familiar artificial limb. The new appliances are designed with a practical aim only in view; they vary according to the trade in which the individual is to engage. For example, the appliance for a machinist would be quite different from that with which a wood turner would be provided. Some appliances have attached to the stump a chuck in which various tools or hooks can interchangeably be held. The wearer uses these devices only while at work; for evenings and holidays he is provided with a 'dress arm' which is made in imitation of the lost natural member.

"An important factor in the success of re-educational work is an early start, so that the disabled man shall have no chance to go out unemployed into the community. In even a short period of exposure to the sentimental sympathy of family and friends, his 'will to work' is so broken down that it becomes difficult again to restore him to a stand of independence and ambition. For this reason, therefore, the plan for his future is made at as early a date as his physical condition admits, and training is actually under way before the patient is out of the hospital.

"In the readjustment of the crippled soldier to civilian life his placement in employment is a matter of the greatest moment. In this field the employer has a very definite responsibility.

"But the employer's duty is not entirely obvious. It is, on the contrary, almost diametrically opposite to what one might superficially infer it to be. The duty is not to 'take care of' from patriotic motives, a given number of disabled men, finding for them any odd jobs which are available, and putting the ex-soldiers in them without much regard to whether they can earn the wages paid or not.

"Yet this method is all too common. A local committee of employers will deliberate about as follows: 'Here are a dozen crippled soldiers for whom we must find jobs. Jones, you have a large factory; you should be able to take care of six of them. Brown, can you not find places for four of them in your warehouses? And Smith, you ought to place at least a couple in your store.'

"Such a procedure cannot have other than pernicious results. In the first years of the war the spirit of patriotism runs high, but experience has shown that men placed on this basis alone find themselves out of a job after the war has been over several years, or, in fact, after it has been in progress for a considerable period of time.

"A second weakness in this method is that a man who is patronized by giving him a charity job, comes to expect as a right such semi-gratuitous support. Such a situation breaks down rather than builds up character, and makes the man progressively a weaker than a stronger member of the community. We must not do our returned men such injury.

"The third difficulty is that such a system does not take into account the man's future. Casual placement means employment either in a make-shift job as watchman or elevator operator such as we should certainly not offer our disabled men except as a last resort—or in a job beyond the man, one in which, on the cold-blooded considerations of product and wages, he cannot hold his own. Jobs of the first type have for the worker a future of monotony and discouragement. Jobs of the second type are frequently disastrous, for in them a man, instead of becoming steadily more competent and building up confidence in himself, stands still as regards improvement and loses confidence every day. When he is dropped or goes to some other employment, the job will have had for him no permanent benefit.

"Twelve men sent to twelve jobs may all be seriously misplaced, while the same twelve placed with thought and wisdom and differently assigned to the same twelve jobs may be ideally located. If normal workers require expert and careful placement, crippled candidates for employment require it even more.

"The positive aspect of the employer's duty is to find for the disabled man a constructive job which he can hold on the basis of competency alone. In such a job he can be self-respecting, be happy, and look forward to a future. This is the definite patriotic duty. It is not so easy of execution as telling a superintendent to take care of four men, but there is infinitely more satisfaction to the employer in the results, and infinitely greater advantage to the employee. And it is entirely practical, even in dealing with seriously disabled men.

"A cripple is only debarred by his disability from performing certain operations. In the operations which he can perform, the disabled man will be just as efficient as his non-handicapped colleague, or more so. In the multiplicity of modern industrial processes it is entirely possible to find jobs not requiring the operations from which any given type of cripples are debarred. For such jobs as they can fill the cripple should be given preference.

"Thousands of cripples are now holding important jobs in the industrial world. But they are men of exceptional character and initiative and have, in general, made their way in spite of employers rather than because of them. Too many employers are ready to give the cripple alms, but not willing to expend the thought necessary to place him in a suitable job. This attitude has helped to make many cripples dependent. With our new responsibilities to the men disabled in fighting for us, the point of view must certainly be changed. What some cripples have done, other cripples can do—if only given an even chance.

"The industrial cripple should be considered as well as the military cripple, for in these days of national demand for the greatest possible output there should not be left idle any men who can be made into productive workers.

"With thoughtful placement effort, many men can be employed directly on the basis of their past experience. With the disabled soldiers who profit by the training facilities the government will provide, the task should be even easier.

"This, then, constitutes the charge of patriotic duty upon the employer:

"To study the jobs under his jurisdiction to determine what ones might be satisfactorily held by cripples. To give the cripples preference for these jobs. To consider thoughtfully the applications of disabled men for employment, bearing in mind the importance of utilizing to as great an extent as possible labor which would otherwise be unproductive. To do the returned soldier the honor of offering him real employment, rather than proffering him the ignominy of a charity job.

"If the employer will do this, it will be a great factor in making the complete elimination of the dependent cripple a real and inspiring possibility."

ANNOUNCEMENTS

The Reading Room of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

FUTURE MEETINGS

September 4th and 18th, 1918.—8.30 P. M.—Meetings will be held on these evenings as usual, and announcement of the speakers and subjects will be made later.

SEARCHES IN THE LIBRARY

In January, 1902, the Secretary was authorized to make searches in the Library, upon request, and to charge therefor the actual cost to the Society for the extra work required. Since that time many searches have been made, and bibliographies and other information on special subjects furnished.

The resulting satisfaction to the members who have made use of the resources of the Society in this manner has been expressed frequently, and leaves little doubt that if it were generally known to engineers that such assistance could be had, many would avail themselves of it.

On October 1st, 1916, the Library of the American Society of Civil Engineers ceased to exist as such, and was merged in the Engineering Societies Library, adding 67 000 volumes to the collection, which comprises also the former libraries of the American Institute of Mining Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, and now has a total of 133 000 volumes and pamphlets. Containing, as the Library now does, the special collections mentioned, its scope is broadened, and, as it receives an unusually large number of technical periodicals, it is well equipped to continue the service formerly rendered by the Society Library.

The Engineering Societies Library offers this service at a cost which is trifling compared with the value of the time of an engineer who personally looks up such matters, and the work can be performed quite as well, and much more quickly, by persons familiar with the Library.

In asking that such work be undertaken, members should specify clearly the subject to be covered, and whether references to general books only are desired, or whether a complete bibliography, involving search through periodical literature, is desired.

It sometimes happens that references are found which are not readily accessible to the person for whom the search is made. In that case the Library is prepared to furnish photographic copies of the material at a small price per page. This method is particularly useful when there are drawings or figures in the text, which would be very expensive to reproduce by hand.

The Library is also able to provide translations of articles in foreign languages when desired.

Requests for searches, copies, translations, etc., should be addressed to the Director, Engineering Societies Library, 29 West 39th Street, New York City, who will gladly give information concerning the charges for the various kinds of service.

PAPERS AND DISCUSSIONS

Members and others who take part in the oral discussions of the papers presented are urged to revise their remarks promptly. Written communications from those who cannot attend the meetings should be sent in at the earliest possible date after the issue of a paper in *Proceedings.*

All papers accepted by the Publication Committee are classified by the Committee with respect to their availability for discussion at meetings.

Papers which, from their general nature, appear to be of a character suitable for oral discussion will be published as heretofore in *Proceedings,* and set down for presentation to a future meeting of the Society, and, on these, oral discussions, as well as written communications, will be solicited.

All papers which do not come under this heading, that is to say, those which from their mathematical or technical nature, in the opinion of the Committee, are not adapted to oral discussion, will not be scheduled for presentation to any meeting. Such papers will be published in *Proceedings* in the same manner as those which are to be presented at meetings, but written discussions only will be requested for subsequent publication in *Proceedings* and with the paper in the volumes of *Transactions.*

The Board of Direction has adopted rules for the preparation and presentation of papers, which will be found on page 35 of the Year Book for 1918.

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association, Organized 1905.

Jerome Newman, President; Nathan A. Bowers, Secretary-Treasurer, 502 Rialto Building, San Francisco, Cal.

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet, and weekly informal luncheons. The former are held at 6 P. M., at the Palace Hotel, on the third Tuesday of February, April, June, August, October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at noon, every Wednesday, at the Engineers' Club, 57 Post Street, where special tables are reserved for members and guests of the Association.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest.

(Abstract of Minutes of Meeting)

June 18th, 1918.—The meeting was called to order at the Palace Hotel; President Newman in the chair; Nathan A. Bowers, Secretary; and present, also, 59 members and guests.

The Entertainment Committee provided a speaker, Dr. Josef Morehodge, who described his experience on the Russian front and later as a captive in Germany.

It was announced that word had been received from various members of the Association now in the service, including Capt. Joseph A. Kitts, and Sergeant Bolin who had arrived safely in France; Capt. Charles Gilman Hyde, of the Sanitary Corps, at Fort Oglethorpe, Ga.; Capt. M. H. Brinkley, of the Engineer Corps, at Washington, D. C., and H. J. Brunnier, present at the meeting, now Chief Assistant Engineer, Department of Concrete Ship Construction, Emergency Fleet Corporation, at Philadelphia, Pa.

President Newman appointed Messrs. F. C. Herrmann, L. L. Hohl, and S. T. Harding, as the Entertainment Committee for the August meeting.

The Secretary read a communication from the Cleveland Association, inviting the Association to name a representative to a Joint Association Conference for the discussion of Society affairs. Communications from the Duluth and Chicago Associations relative to the plan, were also read. On motion, duly seconded, it was decided to refer the matter to a committee of three, with instructions to report at the August meeting. President Newman subsequently appointed Messrs. Kibbe, White, and Vensano as such Committee.

The Secretary reported that the Employment Bureau conducted by the Association was in active condition, the list of applications having been brought up to date and that calls for men were being received more frequently than heretofore. Members were urged to report promptly to the office of the Secretary any vacancies which come to their attention.

Mr. Haehl, speaking for the Licensing Committee, reported that an engineers' and architects' licensing bill had been prepared by Los Angeles architects and would undoubtedly be proposed at the next session of the Legislature, and asked what policy and course of action was desired by the Association on the part of the Committee. After discussion of the subject by Messrs. Hazen, Huber, Saph, Kibbe, Brunnier, Chew, Jessup, and Nishkian, it was decided, on motion, duly seconded, to postpone discussion of the licensing question until the August meeting of the Association, the Committee, in the meantime, to act in the matter at its discretion.

At the second session of the meeting, which was called at 8 P. M., there were present, in addition to the members of the Association, members of the Mechanical, Electrical, and Mining Engineers' Societies, bringing the total attendance up to 125.

An address on "The Present Crisis", was presented by Charles Mills Gayley, Dean of the Faculties of the University of California.

A vote of thanks was tendered Professor Gayley for his interesting address.

Adjourned.

Colorado Association, Organized 1908.

L. R. Hinman, President; A. N. Miller, Secretary-Treasurer, 1122 Detroit Street, Denver, Colo.

The meetings of the Colorado Association of Members of the American Society of Civil Engineers (Denver, Colo.) are held on the second Saturday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary. The meetings are usually preceded by an informal dinner. Members of the American Society of Civil Engineers will be welcomed at these meetings.

Weekly luncheons are held on Wednesday at 12.30 P. M., at Daniels and Fisher's.

Visiting members are urged to attend the meetings and luncheons.

(Abstract of Minutes of Meetings)

April 13th, 1918.—The meeting was called to order at the Denver Athletic Club; Vice-President W. C. Huntington in the chair; L. R. Hinman, Secretary; and present, also, 13 members and 1 guest.

The minutes of the meetings of February 9th and March 9th, 1918, were read and approved.

The Secretary read a letter from the Secretary of the Engineering Foundation relative to industrial laboratories in the vicinity of Denver which are engaged on research work.

The Secretary announced the receipt of an invitation to the members of the Association to attend a special meeting of the Denver Section of the American Institute of Electrical Engineers, to be addressed by Mr. Sheppard, of the United States Bureau of Standards.

Mr. George G. Anderson addressed the meeting on conditions in California relative to the war.

Mr. Huntington spoke of recently published data showing the contribution of various universities throughout the country to war work, and pointed out that the University of Colorado headed the list in the number of men filling prominent positions in the service.

A paper by Mr. Arthur O. Ridgway, entitled "Our Railroads in War Time", was presented by the author, who showed the tabulated data with lantern slides. There was a general discussion of the subject, and a vote of thanks was tendered Mr. Ridgway for his paper.

The paper was followed by an informal discussion on subjects relative to the war.

Adjourned.

May 11th, 1918.—The meeting was called to order at the Denver Athletic Club; E. F. Vincent in the chair; L. R. Hinman, Secretary; and present, also, 9 members and 1 guest.

The minutes of the meeting of April 13th, 1918, were read and approved.

The Secretary announced the appointment of Messrs. Thomas W. Jaycox, Chairman, T. L. Wilkinson, and A. O. Ridgway as the Nominating Committee, by direction of President Follansbee.

A letter from Charles Warren Hunt, Secretary of the Society, with a copy of the action taken by the Board of Direction regarding the resolutions adopted by this and other Associations, relative to the sections of the War Revenue Act of 1917 affecting engineers, was read by the Secretary.

The Secretary announced the receipt from the Cleveland Association, of resolutions adopted by that Association, suggesting a Joint Association Constitutional Conference, and also read a letter from the Duluth Association relative to these resolutions. On motion, duly seconded, consideration of this matter was deferred until the Annual Meeting of the Association in June.

A discussion of the subject, "Highways and Highway Engineering", was opened by Mr. Charles W. Comstock, who was followed by Messrs. Vincent, Palen, Jaycox, and Johnson.

Adjourned.

Atlanta Association, Organized 1912.

B. M. Hall, President; Thomas P. Branch, Secretary-Treasurer, Georgia School of Technology, Atlanta, Ga.

(Abstract of Minutes of Meeting)

July 5th, 1918.—The meeting was called to order at the Chamber of Commerce Building, at 8.30 P. M.; President Benjamin M. Hall in the chair; Thomas P. Branch, Secretary.

The resignation of Mr. W. C. Spiker as Secretary, on account of absence from the city in connection with war work, was accepted, and Professor Thomas P. Branch was elected to succeed him.

The new activities of the Society under war conditions, as well as the necessary preparation by the Association to meet such changed conditions, were considered.

Adjourned.

Baltimore Association, Organized 1914.

H. G. Perring, President; Charles J. Tilden, Secretary-Treasurer, The Johns Hopkins University, Baltimore, Md.

(Abstract of Minutes of Meeting)

May 8th, 1918.—The Annual Meeting was called to order at 8.50 P. M.; Vice-President W. F. Strouse in the chair; C. J. Tilden, Secretary; and present, also, 12 members.

The minutes of the Annual Meeting of May 2d, 1917, and of the meeting of the Board of Directors of April 17th, 1918, were read and approved.

A letter from the Connecticut Society of Civil Engineers regarding the formation of student branches of the Society, was read by the Secretary, and on motion, duly seconded, was ordered to be filed.

The Secretary presented a letter from the Cleveland Association relative to a joint conference of the Local Associations on the matter of proposed amendments to the Constitution of the Society. After some discussion, on motion, duly seconded, the matter was laid on the table.

The Secretary also presented a letter from the American Association of Engineers of Chicago, enclosing a questionnaire for all engineering societies in America. On motion, duly seconded, the Secretary, was instructed to reply that the Association is a Local Association of the American Society of Civil Engineers, and to answer the questionnaire in such manner as he thought fitting.

The Secretary-Treasurer presented his Annual Report for the year ending May 1st, 1918, which covers a summary of the letter-ballot on the proposed revision of the Constitution of the Association, receipts and expenditures, and membership.

The question of suspending the activities of the Association during the war, was raised and discussed. On motion, duly seconded, it was decided that the Association remain active, at least during the coming year. It was further voted that every Thursday, at 1 P. M., members, who can conveniently do so, meet at the Chancery Inn for lunch, and the Secretary was instructed to notify the active membership to that effect.

Vice-President Strouse appointed Messrs. Hartman, Doeleman, and Tilden a Committee to nominate a candidate for President for the ensuing year, that being the only office to be filled under the revised Constitution of the Association. Mr. H. G. Perring was nominated for the office and, on motion, duly seconded, was declared elected.

Adjourned.

Cleveland Association, Organized 1914.

Harry Fuller, President; George H. Tinker, Secretary-Treasurer, 516 Columbia Building Cleveland, Ohio.

(Abstract of Minutes of Meeting)

July 13th, 1918.—The meeting was called to order at 12.15 P. M., at the rooms of the Cleveland Engineering Society; President Fuller in the chair; George H. Tinker, Secretary; and present, also, 17 members.

The minutes of the meeting of February 23d, 1918, were read and approved.

The Secretary-Treasurer made a statement as to the membership and finances of the Association.

The Secretary reported that the Executive Committee had appointed Messrs. Willard Beahan, A. J. Himes, and G. H. Tinker as delegates to the meeting of the Committee on Engineering Co-operation, on May 14th, 1918, but that none of them had been able to attend.

Announcement was made relative to the registration of engineers with the United States Employment Service.

The Secretary announced that Mr. Himes had resigned as a member of the Nominating Committee of the Society, and that Mr. Tinker had been appointed by the Board of Direction to complete his term of office.

Letters were read from A. D. Flinn, Secretary of Engineering Council, relative to his contemplated visit to Cleveland, and, on motion, duly seconded, the Secretary was directed to arrange with the Secretary of the Cleveland Engineering Society for a joint meeting on August 13th, 1918, the date of Mr. Flinn's visit.

On motion, duly seconded, the Secretary was also directed to arrange for the entertainment of Mr. W. H. Finley during his visit on September 10th, 1918.

The Secretary read a communication from the Board of Direction relative to the visit of the President, Secretary, or the Director from this District, and, on motion, duly seconded, he was directed to arrange for such visit.

A resolution by the Detroit Section of the American Society of Mechanical Engineers concerning instruction for women in drafting and inspection of structural materials, which was transmitted to the Association by the Board of Direction, was read. During the discussion which followed, it was stated that the Case School of Applied Science provides a summer course in drafting for women, and that women have been employed in many drafting-rooms in Cleveland. On motion, duly seconded, the Secretary was directed to call the attention of the President of Case School to the matter of instruction for the inspection of structural materials.

The Secretary announced that replies had been received from a majority of the Local Associations in regard to the organization of a Joint Association Constitutional Conference, and that nearly all the Associations heard from were in favor of such action.

The resolutions of the Board of Direction authorizing the organization of a Committee on Development of the Society, were read, and, after general discussion, on motion, duly seconded, the following preamble and resolutions were unanimously adopted:

"*Whereas*, at a meeting of the Cleveland Association of Members, A. S. C. E., held on February 23d, 1918, a resolution was passed inviting the Local Associations to join in the organization of a Joint Association Constitutional Conference, and

"*Whereas,* subsequently a number of the Associations expressed themselves as in favor of said conference, and

"*Whereas,* three Associations, in accepting the invitation to participate in such conference, stipulated that the Board of Direction should be represented, and

"*Whereas,* on June 18th, 1918, the Board of Direction adopted a preamble and resolution authorizing the creation of a Committee 'to report on the purposes, field of work, scope of activity and usefulness, and methods of work of the American Society of Civil Engineers, and to make recommendations concerning these matters', and

"*Whereas,* any such Committee to accomplish the most good must be free and unconstrained in its deliberations and activity; therefore, be it

"*Resolved,* that the Cleveland Association of Members endorses the action of the Board of Direction as a step toward the democratization and vitalization of the American Society of Civil Engineers;

"*Resolved,* that the Cleveland Association of Members accepts its share in this work and pledges its best efforts in furthering the advancement of the Society and the Engineering Profession;

"*Resolved,* that while disclaiming the intention to impugn the motives or question the honesty of purpose of any person, the Cleveland Association of Members believe (1) that three members at large is a sufficient number to represent those members of the Society not represented by a Local Association; (2) that the proposed method of appointing an executive committee and chairman is unwise and calculated to defeat the presentation of a fair and impartial report. The committee is 'to report' and 'to make recommendations'. No small number of members should be empowered to speak for the committee or to control its activities. The committee should perfect its own organization, and outline its programme of work without outside constraint.

"*Resolved,* that the Board of Direction is hereby requested to reconsider its action in respect to the above features.

"*Resolved,* that a copy of these Resolutions be sent to each of the Local Associations and that the proposed Joint Association Constitutional Conference be considered merged into the committee authorized by the Resolution of the Board of Direction passed June 18th, 1918."

On motion, duly seconded, President Fuller was authorized to appoint a member of the Committee from this Association.

Adjourned.

Detroit Association, Organized 1916.

T. A. Leisen, President; Clarence W. Hubbell, Secretary, 2348 Penobscot Building, Detroit, Mich.

The regular meetings of the Association are held on the second Friday of December, April, and October, the last being the Annual Meeting.

District of Columbia Association, Organized 1916.

A. P. Davis, President; John C. Hoyt, Secretary-Treasurer, U. S. Geological Survey, Washington, D. C.

Duluth Association, Organized 1917.

W. B. Patton, President; Walter G. Zimmermann, Secretary, Wolvin Building, Duluth, Minn.

The regular meetings of the Association are held at noon on the third Monday of each month (usually at the Kitchi Gammi Club), with luncheon, followed by a short business session and the reading of papers. Visiting members of the American Society of Civil Engineers can secure from the Secretary definite information relating to the meetings, at which they will be welcomed. The Annual Meeting is held on the third Monday in May.

(Abstract of Minutes of Meetings)

May 20th, 1918.—The Annual Meeting was called to order; President F. E. House in the chair; Walter G. Zimmermann, Secretary; and present, also, 26 members and 3 guests: Richard B. Khuen, M. Am. Soc. C. E., President of the Pittsburgh Association: P. E. Thian, M. Am. Soc. C. E., President of the Northwestern Association; and Mr. Kirby L. Strickland, Division Erecting Manager of the American Bridge Company, Chicago, Ill.

The following officers were elected for the ensuing year: President, W. B. Patton; First Vice-President, Clarence Coleman; Second Vice-President, W. A. Clark; Treasurer, John Carson; and Secretary, Walter G. Zimmermann. The Board of Directors will consist of these officers and Messrs. E. R. Lewis and F. E. House.

The Secretary read letters from several Local Associations in regard to the proposed Association Constitutional Conference suggested by the Cleveland Association, after which President House called on Mr. Khuen to make a few remarks regarding the action of the Pittsburgh Association in considering the proposed Conference. Mr. Khuen stated that the members of that Association were heartily in favor of such Conference.

Mr. Thian stated that the Northwestern Association had not yet taken action in regard to the proposed Conference, but expected to do so at its next meeting.

After further discussion, on motion, duly seconded, the Committee recently appointed, consisting of Messrs. Clark, Taylor, Christie, and Reed, was instructed to draw up a set of resolutions expressing the sympathy of the Association with the Conference suggested by the Cleveland Association, that the Association be represented at such Conference, if held, and that copies of this resolution be sent not only to the Cleveland Association, but to all other Local Associations, and also to the Board of Direction.

Mr. Carson presented the Annual Report of the Treasurer, showing that the total receipts during the year were $118.65 and the total disbursements $106.50, leaving a balance of $12.25. A bill for printing of $15.04, was presented and approved for payment.

After further discussion of the question of the publication of papers read before the Association on motion, duly seconded, the Committee, consisting of Messrs. Ash, Taylor and Stack, was instructed to look further into the matter and report at the next meeting.

On motion, duly seconded, a rising vote of thanks was given the retiring President, Mr. House, for his loyalty and interest in presiding over and building up the Duluth Association, not only during its informal existence from November, 1914, to May, 1917, but also during the first year of its formal organization.

Announcement was also made that Mr. House had just received the honorary degree of "Master of Civil Engineering" from Rensselaer Polytechnic Institute, Troy, N. Y.

In closing, Mr. House expressed his appreciation of the vote given him by the members and pledged his further loyal support to the Association.

Adjourned.

June 17th, 1918.—The meeting was called to order at the Kitchi Gammi Club; President W. B. Patton in the chair; Walter G. Zimmermann, Secretary; and present, also, 20 members and 2 guests.

President Patton announced the appointment of the following Committees for 1918-19: Entertainment, E. R. Lewis and W. A. Clark; Publicity, W. E. Hawley and W. H. Woodbury; Papers and Records, H. C. Ash, J. R. Stack, and G. A. Taylor; Auditing, W. H. Woodbury and George Bryan; Proposed Associational Conference, W. A. Clark, G. A. Taylor, C. D. Christie, and D. A. Reed; Proposed Engineers' Club, W. H. Hoyt, and W. H. Woodbury.

The Secretary read a letter from Alfred D. Flinn, Secretary of the Engineering Council, New York City, relative to a proposed trip which Mr. Flinn expects to make, from coast to coast, during July and August, in order to visit cities in which there are large numbers of engineers. On motion, duly seconded, it was decided to suggest to Mr. Flinn that if he will fix a date for a meeting with the engineers of Duluth and give the Association about ten days' notice, arrangements will be made for such meeting.

The following resolution, prepared by the Committee on Proposed Association Constitutional Conference, on May 31st, 1918, was ratified by a vote of all the members:

"*Whereas,* The Cleveland Association of Members of the American Society of Civil Engineers has suggested that all Local Associations send delegates to a proposed constitutional conference, and

"*Whereas,* The Association is convinced that under methods of procedure employed in the past, it is almost impossible to secure a satisfactory revision of the Constitution, therefore be it

"*Resolved:* That this Association is in sympathy with the plan proposed by the Cleveland Association and favors the sending of a delegate, provided the Local Associations generally participate and that the Board of Direction of the parent Society be invited to send a delegate, and be it further

"*Resolved:* That a copy of these resolutions be sent to each of the Local Associations of Members of the American Society of Civil Engineers, and to the Board of Direction in New York."

A paper by Mr. W. H. Woodbury, entitled, "Description of and Discussion of the Economics Involved in the Proposed Revision and Double Tracking of the Canadian Pacific Railway Company's Line at Notch Hill, British Columbia," was presented by the author.

Adjourned.

July 15th, 1918.—The meeting was called to order; President W. B. Patton in the chair; Walter G. Zimmermann, Secretary; and present, also, 19 members and 1 guest.

The Secretary read a letter from Secretary Chas. Warren Hunt in reference to the resolution, adopted by the Board of Direction of the Society, on June 18th, 1918, relative to the appointment of a delegate from each Local Association to a Committee on Development of the Society. Chairman Clark, of the Committee on Proposed Association Constitutional Conference, stated that that Committee to which this matter had been referred, recommended the appointment of a delegate. On motion, duly seconded, Past-President House was appointed a delegate, with Mr. W. H. Hoyt as alternate, not only to the Committee of the Society but also to the conference proposed by the Cleveland Association, if such conference is held.

On motion, duly seconded, it was decided that the Committee on Proposed Association Constitutional Conference, consisting of Messrs. Clark, Christie, Taylor, and Reed be continued as an Advisory Committee to the delegate.

On motion, duly seconded, the Secretary was directed to communicate further with the Cleveland Association relative to the action of the Association in appointing a delegate, and request information as to the attitude of the Cleveland Association in this matter, as well as in that of the proposed conference, advising that Association that the Duluth Association desired to co-operate in the matter of the proposed conference, unless the Committee on Development of the Society could accomplish the same purpose.

The Secretary read a letter from Secretary Hunt relative to a resolution adopted by the Detroit Engineering Society on the subject of providing special instruction for women students for engineering positions, but no action was taken by the meeting.

A letter was read from Secretary Hunt referring to the resolution adopted by the Board of Direction on June 18th, 1918, relative to an annual visit to the Local Associations by the Director in that District or by the President or Secretary of the Society, and on motion, duly seconded, it was decided to extend a standing invitation by the Association for such visit.

The Secretary read a letter from Alfred D. Flinn, Secretary of Engineering Council, in further reference to his proposed Western trip, stating that his visit to Duluth would be from August 4th to 6th, 1918, inclusive. The Secretary reported that Mr. Flinn's letter had been referred to the Chairman of the Committee on the Proposed Engineers Club, with a view to having that Committee arrange for Mr. Flinn's entertainment. On motion, duly seconded, the Secretary's action was approved.

Mr. Hoyt, for the Committee on the Proposed Engineers Club, reported that plans for the organization of the Club were progressing satisfactorily, as well as the plans for the entertainment of Mr. Flinn.

A paper entitled "Engineering Unity", by Mr. James A. Lawrie, was presented by the author, and there was also brief discussion of previous papers presented by Messrs. Ayres and Woodbury.

Adjourned.

Illinois Association, Organized 1916.

A. S. Baldwin, President; Edgar S. Nethercut, Secretary-Treasurer, 705 Michigan Ave., Evanston, Ill.

The regular meetings of the Association are held on the second Monday of March, June, September, and December, the last being the Annual Meeting. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary.

Louisiana Association, Organized 1914.

W. B. Gregory, President.

The regular meetings of the Association are held at The Cabildo, New Orleans, La., on the first Monday of January, April, July, and October.

Nebraska Association, Organized 1917.

George L. Campen, President; Homer V. Knouse, Secretary-Treasurer, 115 City Hall, Omaha, Nebr.

Regular meetings of the Association are held on the first Saturday of each month, except July and August, and at such places as may be appointed from time to time by the Executive Committee. The Annual Meeting is held in Lincoln, Nebr., on the second Friday in January.

An "Engineers' Round Table" is reserved daily for luncheons, at Courtenay's Restaurant, 17th and Douglas Streets, Omaha, to which all engineers are invited. Visiting members of the Society are especially urged to communicate with the Secretary when in the city.

Northwestern Association, Organized 1914.

P. E. Thian, President; Ralph D. Thomas, Secretary, 508 South First Street, Minneapolis, Minn.

The meetings of the Association are held by-monthly, alternating between St. Paul and Minneapolis, on the third Friday of each month. Information as to the time and place of such meetings will be furnished on application to the Secretary.

Philadelphia Association, Organized 1913.

Henry H. Quimby, President; C. W. Thorn, Secretary, 1313 South Broad Street, Philadelphia, Pa.

The regular meetings of the Association are held at the Engineers' Club of Philadelphia, 1317 Spruce Street, on the first Monday in January, April, and October, the last being the Annual Meeting.

(Abstract of Minutes of Meeting)

July 8th, 1918.—A special meeting of the Board of Direction of the Association was called to order at 5 P. M., at the Union League; President Henry H. Quimby in the chair; C. W. Thorn, Secretary; and present, also, Messrs. Richard L. Humphrey, W. L. Stevenson, and Samuel T. Wagner.

On motion, duly seconded, Mr. Richard L. Humphrey was elected to represent the Association on the Committee on Development of the American Society of Civil Engineers, in accordance with the resolution adopted by the Board of Direction of the Society at its meeting of June 18th, 1918.

Mr. Samuel T. Wagner was appointed Chairman of the Nominating Committee *re* Mr. E. B. Temple resigned.

On motion, duly seconded, it was decided not to fill the unexpired term of the late Edgar Marburg on the Board of Direction.

Mr. Henry T. Shelly was elected to fill the vacancy on the Board of Direction *re* Mr. John F. Murray resigned.

Mr. Wager Fisher was appointed as representative on the Publication Committee.

Mr. Quimby spoke relative to the adoption of new measures to liven up interest in the Association and its meetings, suggesting that speakers be obtained to give short talks on the functions of the Local Associations, to be followed by a general discussion of the subject, with the idea of bringing out the impressions of the Junior members as to what is lacking in the Association and its meetings.

Mr. Humphrey announced that he would obtain several "4-minute men", as speakers for the next regular meeting of the Association in October. The meeting will be advertised among the membership under the heading "Discussion of Position of the Engineer in the Community and the Value to the Engineer of the Association," in order that members may be prepared for discussion after the talks by the "4-minute men."

The following resolution was adopted:

"*Resolved:* That the Board of Direction of the Philadelphia Association of Members of the American Society of Civil Engineers, record with the deepest regret, the loss which they and the Engineering profession at large have sustained by the death of Edgar Marburg on June 27th, 1918.

"As a member of the Board and a Vice-President since April, 1915, he was a most faithful worker and was always keenly alive to the best interests of the Society and the Association. His remarkable energy, enthusiasm and sincerity will always be remembered by those who were privileged to have been associated with him."

Adjourned.

Pittsburgh Association, Organized 1917.

Richard Khuen, Jr., President; John D. Stevenson, Secretary-Treasurer, 1231 Monterey St., Pittsburgh, Pa.

The Annual Meeting of the Association is held on the first Monday in October. The time and place of other meetings are not fixed, but this information will be furnished on application to the Secretary.

Portland, Ore., Association, Organized 1913.

Philip H. Dater, President; C. P. Keyser, Secretary, 1147 East Yamhill Street, Portland, Ore.

(Abstract of Minutes of Meeting)

May 8th, 1918.—The meeting was called to order at the University Club, at 8 P. M.; President Dater in the chair; C. P. Keyser, Secretary; and present, also, 15 members.

The minutes of the meetings of the Association of February 15th, 1918, and of the Board of Directors of March 20th, 1918, were read and approved.

Communications from Charles Warren Hunt, Secretary of the Society, relative to the War Revenue Act of 1917, from the San Francisco Association in reference to active representation on the Nominating Committee of the Society, from the Cleveland Association relative to an open forum for the discussion of matters vital to the Society, and from the American Association of Engineers in regard to delegates to its Convention to be held in Chicago, Ill., on May 14th, 1918, were read and ordered filed.

Several bills were presented and ordered paid.

On motion, duly seconded, the Secretary was instructed to write to Secretary Hunt, asking him to designate a method of procedure to insure active representation, for District No. 12, on the Nominating Committee at its next meeting, and the Board of Directors was named as a committee with power to act in the matter on receipt of reply from Mr. Hunt.

On motion, duly seconded, the Board of Directors was empowered to name a delegate to the conference, proposed by the Cleveland Association, in the interest of a more democratic control of the Society.

The matter of delegates to the Convention of the American Association of Engineers in Chicago, as well as the questionnaire from that Association, was, on motion, duly seconded, ordered laid on the table.

President Dater presented a request from Maj. H. C. Boyden, of San Francisco, Cal., that the Association obtain and compile certain information relative to the military records of the Portland District.

On motion, duly seconded, a committee of three, consisting of Messrs. Mason, Reed, and Randlett, was appointed, first, to investigate existing military records, and, second, if the required information was found, to deliver it to the Government.

The question of the registration of technical men was taken up and discussed. On motion, duly seconded, the matter was put in the hands of the President, and the Committee was discharged.

The Secretary was instructed, by order of the President, to send out notices for the collection of $2.50 for dues for 1918.

It was suggested that the Chairman of the Programme Committee might try to arrange for an excursion to Vancouver Barracks.

The Secretary's "stirring" letter to the membership was taken up, but, owing to the lateness of the hour, the discussion was postponed until May 22d, 1918.

Adjourned.

St. Louis Association, Organized 1888 (Constitution Approved by Board, 1914).

J. A. Ockerson, President; C. M. Daily, Secretary-Treasurer, 34 East Grand Avenue, St. Louis, Mo.

The Annual Meeting of the Association for the election of officers and for the transaction of business, is held on the fourth Monday in November. Two meetings each year, for the presentation and discussion of technical papers, are held in the Auditorium of the Engineers Club of St. Louis and are open to members of the Associated Societies. Other "get-together" meetings are held regularly for dinner or luncheon on the fourth Monday of each month except July, August, and November.

(Abstract of Minutes of Meeting)

July 1st, 1918.—The meeting was called to order at the City Club at 12.30 P. M.; President Ockerson in the chair; C. M. Daily, Secretary; and present, also, 29 members and guests.

President Ockerson read the preamble and resolutions relative to the organization of the Committee on Development of the American Society of Civil Engineers adopted by the Board of Direction of the Society at its meeting of June 18th, 1918, as well as a letter from Secretary Hunt pertaining to the matter.

After discussion of the subject, motion was made and carried that nominations by ballot for member and alternate member of the Committee be made, it having been explained that this Committee is to report on the purposes, field of work, scope of activity and usefulness, organization and methods of work of the Society, and to make recommendations concerning these matters to the Board of Direction not later than November 1st, 1918.

It was decided, on motion, duly seconded, that the two men receiving the highest number of votes should be placed on the ballot (the highest for member and the next highest for alternate member), and the ballot mailed to all members of the Association with instructions to prepare and return it to the Secretary before July 15th, 1918.

Two ballots were cast, twelve nominations being made on the first one. On the second ballot, the names of the five men receiving the highest number of votes on the first one, were voted on, with the result that Messrs. Baxter L. Brown and J. W. Woermann were elected as nominees for membership on the Committee, and the Secretary was instructed to prepare and send out the letter and ballots.

On motion, duly seconded, the Association endorsed the resolution of the Detroit Section of the American Society of Mechanical Engineers and the Detroit Engineering Society in joint session on May 3d, 1918, with regard to providing special instruction open to women students to enable them to fill engineering positions.

Adjourned.

San Diego Association, Organized 1915.

N. B. Kellogg, President; P. R. Watson, Secretary-Treasurer, *pro tem.,* County Surveyor's Office, San Diego, Cal.

Seattle Association, Organized 1913.

A. S. Downey, President; Phil. A. Franklin, Secretary, Care, City Engineer's Office, County-City Building, Seattle, Wash.

The regular monthly meetings and luncheons of the Association are held at the Frye Hotel, 3d Avenue and Yesler Way, at 12.15 P. M., on the last Monday of each month. All members in any grade, of the American Society of Civil Engineers are cordially invited to attend the meetings when in the vicinity.

Southern California Association, Organized 1914.

Louis C. Hill, President; H. W. Dennis, Secretary, Edison Building, Los Angeles, Cal.

The Southern California Association of Members of the American Society of Civil Engineers (Los Angeles, Cal.) holds regular bi-monthly meetings with banquet, at Hotel Clark, on the second Wednesday of February, April, June, August, October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at 12.15 P. M., every Thursday and the place of meeting may be ascertained from the Secretary.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in Los Angeles, and any such member will be gladly welcomed as a guest at any of the meetings or luncheons.

Spokane Association, Organized 1914.

Peter Mogensen, President; Charles E. Davis, Secretary, City Engineer's Office, Spokane, Wash.

The regular meetings of the Association are held on the second Friday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary.

Visiting members are invited to attend the meetings and luncheons.

Texas Association, Organized 1913.

R. C. Gowdy, President; J. H. Brillhart, Secretary, Care, Mosher Mfg. Co., Dallas, Tex.

(Abstract of Minutes of Meetings)

May 10th, 1918.—10.30 A. M.—The first session of the Semi-Annual Meeting of the Association was called to order in the Engineering Building of the Texas Agricultural and Mechanical College, at College Station; R. J. Potts in the chair; J. H. Brillhart, Secretary.

The minutes of the previous meeting were read and approved.

Prof. J. C. Nagle read a letter of welcome to the Association from Dr. Bizzell, President of the College, who was unable to attend, and addresses were made by Dean Puryear, C. H. Chamberlin, and Col. W. A. Poage.

The Treasurer made a verbal report.

The Secretary reported in reference to the action taken by the Association relative to securing a representative on the Nominating Committee of the Society from District No. 11, and also in the matter of the "Excess Profits Tax on Incomes of Engineers", as supported by the Board of Direction of the Society. On motion, duly seconded, the Association endorsed the action of the Board of Direction on this question.

Adjourned.

2.15 P. M.—The meeting was called to order.

On motion, duly seconded, the regular order of business was set aside for the reading of a paper by Prof. R. M. Green, entitled "Experiments on Asphalt Pavements in Various Cities of Texas." A paper by Mr. J. F. Witt, entitled "Some Experiments in Bituminous Surface Treatment on Portland Cement Concrete for Public Highways", was read by Professor R. L. Morrison. These papers were discussed by Messrs. Davis, Bartlett, Nagle, Howell, Morrison, and Potts.

Adjourned.

8.15 P. M.—After a visit by the members to the Testing Laboratory, and witnessing a military drill on the field, followed by supper in the Mess Hall, as guests of the Local Members, the meeting was again called to order.

Papers by Prof. F. E. Giesecke on "Tests on Reinforcing Concrete" and by Prof. S. P. Finch on "Tests on Concrete Formed of Tough Rock for the War Department", were presented by the authors and discussed by Messrs. Davis, Ritchie, and Eliot.

A paper by Mr. C. M. Davis, entitled "Designing", was also presented by the author.

Adjourned.

May 11th, 1918.—8.30 A. M.—After a visit by the members to the Experiment Station, the Textile Plant, and the Aero Mechanics Workshop, the meeting was called to order; President R. C. Gowdy in the chair; J. H. Brillhart, Secretary.

A communication from the Cleveland Association relative to a Joint Association Constitutional Conference was read, and, after some discussion, it was decided, on motion, duly seconded, that the invitation of the Cleveland Association to the Conference be accepted and a delegate and alternate appointed. Mr. Gowdy was appointed as delegate and Mr. Brillhart as alternate.

A report from the Legislative Committee was read, and, on motion, duly seconded, was accepted as a Progress Report.

A letter from Mr. Von Zuben, expressing appreciation of the flag presented to the 111th Engineers, was read.

Messrs. F. W. Chappell and J. Olsen were elected to membership.

On motion, duly seconded, a vote of thanks was tendered to the local members for the hospitality and courtesies extended to the members of the Association during the meeting.

Adjourned.

There were present at the meetings 15 members and 8 guests, as well as many students of the Texas Agricultural and Mechanical College.

The following members of the Texas Association are in active Military Service: Messrs. E. B. Cushing, T. L. Fountain, John B. Hawley, W. J. Powell, and E. E. Woodward, and Messrs. J. C. Nagle, H. E. Elrod, R. L. Morrison, and F. A. Jones are on the Reserve List.

Utah Association, Organized 1916.

George L. Swendsen, President; H. S. Kleinschmidt, Secretary-Treasurer, 306 Dooly Building, Salt Lake City, Utah.

The Annual Meeting of the Association is held on the first Wednesday in April. The time of other meetings is not fixed, but this information will be furnished on application to the Secretary.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcomed by the following Engineering Societies, both to the use of their Reading Rooms, and at all meetings:

American Institute of Electrical Engineers, 25 West Thirty-ninth Street, New York City.

American Institute of Mining Engineers, 25 West Thirty-ninth Street, New York City.

American Society of Mechanical Engineers, 25 West Thirty-ninth Street, New York City.

Asociación de Ingenieros y Arquitectos de Mexico, Avenida Juarez, 12, City of Mexico, Mexico.

Assoçiacão dos Engenheiros Civis Portuguezes, Lisbon, Portugal.

Australasian Institute of Mining Engineers, Melbourne, Victoria, Australia.

Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass.

Brooklyn Engineers' Club, 117 Remsen Street, Brooklyn, N. Y.

Civil Engineers' Society of St. Paul, Public Library, St. Paul, Minn.

Cleveland Engineering Society, Chamber of Commerce Building, Cleveland, Ohio.

Cleveland Institute of Engineers, Middlesbrough, England.

Dansk Ingeniorforening, Amaliegade 38, Copenhagen, Denmark.

Detroit Engineering Society, Detroit Board of Commerce Building, Detroit, Mich.

Engineering Association of Nashville, Commercial Club Building, Nashville, Tenn.

Engineering Association of New South Wales, 5 Elizabeth Street, Sydney, New South Wales, Australia.

Engineering Institute of Canada, 176 Mansfield Street, Montreal, Que., Canada.

Engineering Societies Club of Hawaii, E. F. Cykler, Secretary, Honolulu, Hawaii.

Engineers and Architects Association of Southern California, 405 Hosfield Bldg., Los Angeles, Cal.

Engineers and Architects Club of Louisville, 1412 Starks Building, Louisville, Ky.

Engineers' Club of Baltimore, 6 West Eager Street; Baltimore, Md.

Engineers' Club of Kansas City, Robert S. Beard, Secretary, Third Floor, City Hall, Kansas City, Mo.

Engineers' Club of Minneapolis, 17 South Sixth Street, Minneapolis, Minn.

Engineers' Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa.

Engineers' Club of St. Louis, 3817 Olive Street, St. Louis, Mo.

Engineers' Club of Toronto, 96 King Street, West, Toronto, Ont., Canada.

Engineers' Club of Trenton, Trent Theatre Building, 12 North Warren Street, Trenton, N. J.

Engineers' Society of Northeastern Pennsylvania, 415 Washington Avenue, Scranton, Pa.

Engineers' Society of Pennsylvania, 31 South Front Street, Harrisburg, Pa.

Engineers' Society of Western Pennsylvania, 568 Union Arcade Building, Pittsburgh, Pa.

Florida Engineering Society, J. R. Benton, Secretary, Gainesville, Fla.

Institute of Marine Engineers, The Minories, Tower Hill, London, E., England.

Institution of Civil Engineers, Great George Street, Westminster, S. W., London, England.

Institution of Engineers of the River Plate, Calle 25 de Mayo 195, Buenos Aires, Argentine Republic.

Institution of Mechanical Engineers, 11 Great George Street, London, S. W. 1., England.

Institution of Naval Architects, 5 Adelphi Terrace, London, W. C., England.

Junior Institution of Engineers, 39 Victoria Street, Westminster, S. W., London, England.

Koninklijk Institut van Ingenieurs, The Hague, The Netherlands.

Louisiana Engineering Society, State Museum Building, Chartres and St. Ann Streets, New Orleans, La.

Memphis Engineers' Club, Memphis, Tenn.

Midland Institute of Mining, Civil and Mechanical Engineers, Sheffield, England.

Montana Society of Engineers, Butte, Mont.

North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, England.

Oregon Society of Civil Engineers, Portland, Ore.

Pacific Northwest Society of Engineers, 803 Central Building, Seattle, Wash.

Rochester Engineering Society, Rochester, N. Y.

Sociedad Colombiana de Ingenieros, Bogota, Colombia.

Sociedad de Ingenieros del Peru, Lima, Peru.

Societe des Ingenieurs Civils de France, 19 rue Blanche, Paris, France.

Society of Engineers, 17 Victoria Street, Westminster, S. W., London, England.

Southwestern Society of Engineers, C. E. Barglebaugh, Secretary, 703 First National Bank Building, El Paso, Tex.

Svenska Teknologforeningen, Brunkebergstorg 18, Stockholm, Sweden.

Tekniske Forening, Vestre Boulevard 18–1, Copenhagen, Denmark.

Vermont Society of Engineers, George A. Reed, Secretary, Montpelier, Vt.

Western Society of Engineers, 1735 Monadnock Block, Chicago, Ill.

ACCESSIONS TO THE ENGINEERING SOCIETIES LIBRARY

(From May 1st to August 1st, 1918)

DONATIONS *

The statements made in these notices are taken from the books themselves, and this Society is not responsible for them.

GENERAL LECTURES ON ELECTRICAL ENGINEERING.

By Charles Proteus Steinmetz. 5th ed. Compiled and Edited by Joseph LeRoy Hayden. N. Y., McGraw-Hill Book Company, Inc.; Lond., Hill Publishing Company, 1918. 242 pp., 50 illus., 1 por., 1 tab., 9 x 6 in., cloth. $2.50.

A series of descriptive, non-mathematical lectures on the problems of the generation, control, transmission, distribution, and utilization of electric energy. The present edition has been largely rewritten to include the changes that have taken place in the electrical industry during the last eight years.

STANDARD WIRING FOR ELECTRICAL LIGHT AND POWER:

As Adopted by the Fire Underwriters of the United States, in Accordance with This Year's Edition of the National Electrical Code, with Explanations, Illustrations, and Tables Necessary for Outside and Inside Wiring and Construction for All Systems, Together with a Special Section on House Wiring. By H. C. Cushing, Jr. N. Y., H. J. Cushing, Jr. (copyright 1918). 360 pp., 4 illus., 21 diag., 37 tab., 7 x 4 in., flexible cloth.

This edition of the essential rules and requirements for safe and efficient wiring and construction for electric heat, light, and power, follows the plan adopted in former editions, but has been revised to meet present requirements.

GLOSSAIRE (ANGLAIS-FRANCAIS) DES TERMES

Et Locutions Electrotechniques les Plus Usités. Compilé par Aristide Filiatreault. Montreal, M. J. Filiatreault, 1913. 59 pp., 7 x 4 in., paper.

A moderately priced English-French electrical dictionary of pocket size.

HOW TO SELL ELECTRICAL LABOR-SAVING APPLIANCES;

119 Tested Plans for the Electric Store. Compiled by *Electrical Merchandising*. N. Y., McGraw-Hill Book Company, Inc.; Lond., Hill Publishing Company, Ltd., 1918. 115 pp., 15 illus., 13 pl., 8 x 5 in., one-half cloth. $1.00.

A manual for dealers in electrical supplies and fixtures, suggesting methods for displaying stock, advertising, training clerks, etc.

DIGEST OF PUBLICATIONS OF BUREAU OF STANDARDS

On Electrolysis of Underground Structures Caused by the Disintegrating Action of Stray Electric Currents from Electric Railways. Prepared by Samuel S. Wyer. 1918. 96 pp., 10 x 7 in., paper. (Gift of the Author.)

Summarizes, by verbatim quotations, the essentials of the extensive laboratory and field investigations on this subject which the Bureau of Standards has published up to August 22d, 1916. The quotations selected have been classified, and the compiler has added editorial notes. Copies may be procured from the Bureau of Standards, Washington, D. C.

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* Unless otherwise specified, books in this list have been donated by the publishers.

HOW TO BECOME A WIRELESS OPERATOR:

A Practical Presentation of the Theory of Electrical Waves, Their Propagation, and Their Adaptation to Wireless Communications, Including Simple and Clear Instructions How to Operate Wireless Devices and How to Comply with Government Requirements for Operators. By Charles B. Hayward. Chic., American Technical Society, 1918. 21 + 298 pp., 196 illus., 1 pl., 9 tab., 8 x 6 in., cloth.

This work does not discuss the history nor the mathematics of radiotelegraphy. It is intended for those wishing to become proficient operators, and is designed for individual study.

WOODEN SHIPBUILDING:

A Comprehensive Manual for Wooden Shipbuilders to Which is Added a Masting and Rigging Guide. Compiled by W. J. Thompson. Chic., A. C. McClurg & Co., 1918. 202 pp., 2 tab., 7 x 5 in., flexible cloth. $2.50.

A book of pocket size, compiled from standard authorities, which is intended chiefly as a glossary of the parts of ships and their rigging, with brief descriptions of the methods of construction, arranged in dictionary form. Contents: Wooden Ships; Masts and Rigging; Methods of Masting; Tables of Rigging.

A TEXT-BOOK OF LAYING OFF:

Or, The Geometry of Shipbuilding. By Edward L. Attwood and I. C. G. Cooper. 2d ed. Lond. and N. Y., Longmans, Green and Co., 1918. 123 pp., 121 illus., 2 pl. (1 folded), 9 x 6 in., cloth. $2.00.

This work is intended to provide students of naval architecture and ship draftsmen with a description of the processes and methods used in various shipbuilding yards and centers. The second edition has been revised with a view to greater clearness, and some additions have been made to the text.

MACHINE DESIGN:

A Manual of Practical Instruction in Designing Machinery for Specific Purposes, Including Specifications for Belts, Screws, Pins, Gears, etc., and Many Working Hints as to Operation and Care of Machines. By Ernest L. Wallace. Chic., American Technical Society, 1918. 12 + 157 pp., 90 illus., 2 pl., 9 tab., 8 x 6 in., cloth.

A simple treatment of the subject, adapted for home study and intended for use by machinists, draftsmen, and apprentices.

ELEMENTS OF MACHINE DESIGN.

By Henry L. Nachman. N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1918. 244 pp., 275 illus., 22 tab., 9 x 6 in., cloth. $2.00.

A class-room text on the subject of elementary machine design, for students in technical institutes.

PRINCIPLES OF MECHANISM.

By Walter H. James and M. C. Mackenzie. N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1918. 241 pp., 246 illus., 8 x 5 in., cloth. $1.50.

Presents the elementary principles of mechanism without the use of advanced mathematics. Intended especially for trade schools, etc.

THE MODEL T FORD CAR;

Truck and Tractor Conversion Sets. Also Genuine Ford Farm Tractor Construction, Operation, and Repair. By Victor W. Pagé. N. Y., The Norman W. Henley Publishing Co., 1918. 312 pp., 106 illus., 1 folded pl., 8 x 5 in., cloth. $1.00.

This book is a complete practical treatise, explaining the operating principles of all parts of the Ford automobile, with complete instructions for driving and maintenance, every phase of the subject being treated in a non-technical, yet comprehensive manner.

THE AUTOMOBILE REPAIRMAN'S HELPER:

A Pocket Book for the Mechanic, Owner, Chauffeur, and Student, Covering Every Trouble Likely to be Found in All the Standard Cars and Including Chapters on Inspection and Lubrication; Drills, Taps and Lathes; Welding; Storage Batteries; Cylinder and Piston Ring Work; Bearings; Axle Adjustments; Repairing Tops, Mudguards, Lamps, etc. By S. T. Williams. N. Y., U. P. C. Book Company, Inc. (copyright 1918). 438 pp., 322 illus., 5 x 7 in., flexible cloth. $2.50.

The object of the compiler has been to give the best method of doing each particular job of repairing and also to explain the proper sequence in which the various operations should be done.

AUTOMOBILE CONSTRUCTION AND REPAIR;

A Practical Guide to the Design, Construction, and Repair of Automobile Mechanisms. By Morris A. Hall. Chic., American Technical Society, 1918. 711 pp., 568 illus., 4 pl., 4 tab., 8 x 6 in., flexible leather. $2.50.

Intended for mechanics engaged in automobile construction and repair. Describes the construction of the standard types of transmission, clutches, valves, etc., and gives methods for repairing the troubles that occur in operation.

THE MODERN GASOLINE AUTOMOBILE:

Its Design, Construction, Operation and Maintenance: A Practical, Comprehensive Treatise Explaining all Principles Pertaining to Gasoline Automobiles and Their Component Parts. By Victor W. Pagé. 1918 edition, rev., enl., and reset. N. Y., The Norman W. Henley Publishing Co., 1918. 1 032 pp., 1 000 illus., 11 charts (9 folded), 9 x 6 in., cloth. $3.00.

This edition has been brought to date by careful revision and the introduction of supplementary matter on ignition, tractors, power transmission, carburetion, etc. The book, it is stated, is the most up-to-date treatise on gasoline automobiles ever published, every phase of the subject being treated in a practical, non-technical manner.

DYKE'S AUTOMOBILE AND GASOLINE ENGINE ENCYCLOPEDIA:

Treating on the Construction, Operation, and Repairing of Automobiles, and Gasoline Engines. Also Trucks, Tractors, Airplanes and Motorcycles. By A. L. Dyke. 7th ed., rev. and enl. St. Louis, A. L. Dyke (copyright 1918). 864 pp., illus., charts, tab., cloth, 10 x 7 in. $3.50.

Presents in clear, simple, concise form the principles on which gasoline engines and automobiles are built and operated. Sections are included on repairing, adjusting, and driving, together with much miscellaneous information of value to automobile engineers and drivers. This edition also includes 515 charts, inserts, dictionary, etc., as well as supplements on the Ford and Packard machines, and on airplanes. More than 3 000 illustrations accompany the text.

TIRE MAKING AND MERCHANDISING:

A Book of Facts Concerning Manufacturing Processes, Illustrating the Principal Tire Types, Rims, and Non-skid Treads, with Chapters on Rubber and Other Factors Governing Tire Costs, Present and Future Trend of the Market, Merchandising for Profit, Dividends from Service, Marketing Methods and Sales Campaigns, Tire Equipment of All Pleasure and Commercial Cars from 1913 to Present Date, and a Dealers' Dictionary of Terms. By F. R. Goodell. N. Y., U. P. C. Book Company, 1918. 222 pp., 42 illus., 6 tab., maps, 7 diag., 8 x 5 in., flexible cloth. $2.00.

A compact summary of information on tire manufacture, marketing, and merchandising, designed especially for those engaged in the tire business.

AMERICAN LUBRICANTS;

From the Standpoint of the Consumer. By L. B. Lockhart. Easton, Pa., The Chemical Publishing Co.; Lond., Williams & Norgate; Tokyo, Maruzen Co., Ltd., 1918. 10 + 236 pp., 13 illus., 44 tab., 9 x 6 in., cloth. $2.00.

The purpose of this book is to aid the user of lubricants in the intelligent selection of oils and greases, by giving the facts and figures of value to him and excluding all irrelevant matters. Contents: Crude Petroleum; The Refining of Petroleum; The Refined Products; Friction and Lubrication; Lubrication of Internal Combustion Engines; Automobile Lubrication; The Lubrication of Electrical Machinery; The Lubrication of Steam Cylinders and Steam Engines; The Lubrication of Steam Railways; The Lubrication of Cotton Mills and Other Textile Mills; The Lubrication of Miscellaneous Plants and Machines; Physical Methods of Testing Lubricating Oils; Chemical Methods of Testing Lubricating Oils; Lubricating Greases; Methods for Testing and Analysis of Greases; Animal and Vegetable Oils; Methods of Testing Fatty Oils; Specifications for Fatty Oils; Specifications for Cylinder Oils; Specifications for Special Engine and Machine Oils and Car Oils; Specifications for Cutting Oils; Specifications for Greases; Graphite; Boiler Compound and Cotton Waste; Specifications for Burning Oils; Specifications for Gasoline and Fuel Oil; Gasolines; Kerosene; Tables.

THE CYANIDE PROCESS;

Its Control and Operation. By A. W. Fahrenwald. N. Y., John Wiley and Sons, Inc.; Lond., Chapman and Hall, Ltd., 1918. 10 + 256 pp., 37 illus., 1 folded pl., 1 folded chart, 27 tab., 7 x 4 in., flexible cloth. $2.00.

The object of the book is to furnish a laboratory guide, both for investigating a new ore and for conducting the laboratory of a mill, which will include the latest developments of the process and be sufficiently complete for ordinary needs.

THE CHEMICAL ANALYSIS OF IRON:

A Complete Account of All the Best Known Methods for the Analysis of Iron, Steel, Pig-iron, Alloy Metals, Iron Ore, Limestone, Slag, Clay, Sand, Coal and Coke. By Samuel Alexander Blair. 8th ed. Phila. and Lond., J. B. Lippincott Company (copyright 1918). 318 pp., 102 illus., 2 tab., 9 x 6 in., cloth. $5.00.

In preparing the eighth edition of this well-known handbook, the entire work has been recast and the text largely rewritten to include the recent improved methods.

ELECTRIC FURNACES IN THE IRON AND STEEL INDUSTRY.

By W. Rodenhauser, J. Schoenawa, and C. H. Vom Bauer. Translated from the Original by the Latter and now Completely Rewritten. 2d ed. N. Y., John Wiley & Sons; Lond., Chapman & Hall, Ltd., 1917. 18 + 429 pp., 134 illus., 2 pl., 24 tab., 9 x 6 in., cloth. $3.75.

A review of the electric furnaces utilized in iron smelting, and of the processes used. The present edition contains minor revisions covering certain changes since 1913.

METAL STATISTICS, 1918.

11th Annual Edition. N. Y., The American Metal Market Co. (copyright 1918). 427 pp., 6 x 4 in., cloth. 50 cents.

Tables showing production, prices, imports, exports, etc., of iron ore, coke, iron and steel products, copper, tin, lead, spelter, aluminum, antimony, silver, and other metals. The statistics usually cover a number of years.

MILITARY OBSERVATION BALLOONS (CAPTIVE AND FREE):

A Complete Treatise on Their Manufacture, Equipment, Inspection, and Handling, with Special Instructions for the Training of a Field Balloon Company. By Emil J. Widmer. N. Y., D. Van Nostrand Co., 1918. 151 pp., 38 illus., 3 pl. (2 folded), 8 x 5 in., flexible cloth. $3.00.

This manual is based on the balloon manual of the German army, and the equipment and drill in use by the Germans at the beginning of the war. It gives a complete survey of the field.

TOPOGRAPHY AND STRATEGY IN THE WAR.

By Douglas Wilson Johnson. N. Y., Henry Holt and Company, 1917. 11 + 211 pp., 33 pl., 18 maps, 9 x 6 in., cloth. $1.75.

The author's objects have been to emphasize the effect played by land forms in plans of campaign and movements of armies in the great war, and to place before the reader a picture of each theatre of war that will enable him to follow with intelligence the movements of the troops.

THE FIGHTING ENGINEERS:

The Minute Men of Our Industrial Army. By Francis A. Collins. N. Y., The Century Co., 1918. 220 pp., 31 pl., 8 x 5 in., cloth. $1.30.

A popular account of the work of the American engineering regiments in France and America.

DIRECT COSTS OF THE PRESENT WAR.

By Ernest L. Bogart. The Early Effects of the European War upon the Finance, Commerce, and Industry of Chile. By L. S. Rowe. (Carnegie Endowment for International Peace, Div. of Economics and History. Preliminary Economic Studies of the War.) N. Y., Oxford University Press, 1918. 10 x 7 in., paper. (Gift of the Carnegie Endowment for International Peace.)

These two pamphlets, belonging to a series of economic studies of the effects of the European War, undertaken by the Carnegie Endowment for International Peace, discuss two phases of the question. Prof. Bogart's summary of the cost of the war to each participant covers only the direct financial outlays of the Governments, compiled from the best available reports. Dr. Rowe gives an account of the immediate effects of the war in the period of the fall of 1914 and the spring of 1915, based on a personal investigation during the latter year.

INTERNATIONAL MINING LAW.

By Theo. F. Van Wagenen. N. Y., McGraw-Hill Book Company, Inc.; Lond., Hill Publishing Company, Ltd., 1918. 342 pp., 7 x 5 in., flexible cloth. $3.50.

Starting with an account of ancient mining laws and customs, the author gives a digest of the present mining laws of the world. Statistics of production in the leading countries are given in order to show the effect of various laws on the industry, and there are discussions of different features of the laws. The subject-matter is confined to metal mining; the laws having to do with coal, iron, and non-metals are omitted.

NORTHWEST MINES HANDBOOK:

A Reference Work of the Mining Industry of Idaho, Washington, British Columbia, Western Montana, and Oregon. By Sidney Norman. Vol. I. Spokane, Wash., Sidney Norman, 1918. 366 pp., 28 illus., 9 por., 2 maps (1 folded), 13 tab., 10 x 6 in., cloth. $5.00.

Covers the mining enterprises which surround Spokane. Contains general descriptive articles on mining and geology of each State, statistics of production, and gives lists of mines and mining corporations, showing capital stock, property, and development.

THE COAL CATALOG:

Combined with *Coal Field Directory* for the Year 1918, Containing Explanatory Articles on Rank, Usage, Analysis, Geology, Storage, and Preparation of Coals, Together with a Typical Section of the Productive Formations of Each Coal Mining State in the Union; Maps Showing the Various Mining Districts or Fields; Description of the Seams Mined; Lists of Mines Operating in the Various Seams, Including Name of Company; List of Seams Producing Coal Suitable for Each Industrial Purpose, etc., and a Directory of All the Coal Mines in the United States. Pittsburgh, Keystone Consolidated Publishing Company, Inc. (copyright 1918). 671 pp., 90 illus., 25 maps, 12 x 9 in., cloth. $25.00.

A remarkably complete compendium on the coal industry of the United States and Canada, in which is collected the information needed by producers and users.

POPULAR OIL GEOLOGY.

By Victor Ziegler. Golden, Colo., C. H. Merrifield, 1918. 149 pp., 62 illus., 1 pl., 7 x 5 in., flexible cloth. $2.50.

An exposition of the fundamental principles of oil geology, intended for men without technical training, who are interested in the subject.

MY REMINISCENCES.

By Raphael Pumpelly. 2 Vol. N. Y., Henry Holt and Co., 1918. 844 pp., 57 pl., 24 por., 13 maps, 9 x 6 in., cloth. $7.50.

Born in 1837, the author studied geology and mining engineering in Paris and Freiburg, and later led a busy life as a geologist, mining engineer, and explorer for more than half a century. His professional activities in Asia and America provided an abundance of information on these lands and many adventures and anecdotes, which are presented in an interesting fashion in this autobiography.

MODERN MANAGEMENT APPLIED TO CONSTRUCTION.

By Daniel J. Hauer. N. Y., McGraw-Hill Book Company, Inc.; Lond., Hill Publishing Company, Ltd., 1918. 10 + 194 pp., 19 illus., 1 folded chart, 9 x 6 in., cloth. $2.50.

Describes the application of the principles of scientific management to engineering and architectural construction, in the light of the author's experience. An appendix outlines the American and Canadian organizations for war construction.

SCIENTIFIC MANAGEMENT:

A History and Criticism. By Horace Bookwalter Drury. 2d ed., rev. (Studies in History, Economics and Public Law; Edited by the Faculty of Political Science of Columbia University. Vol. 65, No. 2. Whole number 157.) N. Y., Columbia University, 1918. 251 pp., 10 x 6 in., paper. $2.00. (Gift of Longmans, Green and Co.)

A history of the origins and development of scientific management, with a critical review of its important aspects. Brief biographies of the leaders in the movement are given, and its relation to labor is discussed. The second edition has been largely extended and revised. The statements have been brought down to date, and the conclusions have been rewritten in a number of cases.

THE TAYLOR SYSTEM IN FRANKLIN MANAGEMENT:

Application and Results. By Maj. George D. Babcock, in Collaboration with Reginald Trautschold, with a Foreword by Carl G. Barth. (Industrial Management Library.) N. Y., The Engineering Magazine Company, 1917. 20 + 245 pp., 24 illus., 4 folded charts, 9 x 6 in., cloth. $3.00.

A step-by-step description of the introduction and application of the Taylor system of management in the automobile factory of the H. H. Franklin Manufacturing Company, with an account of the results obtained during the five years that the system has been in use.

HIRING THE WORKER.

By Roy Willmarth Kelly. (Industrial Management Library.) N. Y., The Engineering Magazine Co., 1918. 245 pp., 8 pl., 66 forms, 5 charts (2 folded), 2 tab., 9 x 6 in., cloth. $2.00.

A summary of the efforts of many firms to solve the problems of employment. Describes the theories and policies which have been tested, suggests the possibilities of employment management and attempts to point out the profitable avenues of advancement.

THE EMPLOYMENT DEPARTMENT AND EMPLOYEE RELATIONS.

By F. C. Henderschott and F. E. Weakly. Chic., La Salle Extension University (copyright 1918). 60 pp., 20 illus., 4 tab., 9 x 6 in., paper.

This book contains suggestions based on methods in use by various corporations. The Contents are: Selection of the Employee; The Labor Supply; Promotions and Transfers; Progressive Scale of Promotion Based on General Intelligence Requirements; Employee Records as a Basis for Promotion; Annual Survey of Employees; The Principle of Transfer; The Vocational Laboratory; Job Analysis; Labor Turnover; Educational and Welfare Work.

INDUSTRIAL RECONSTRUCTION;

A Symposium on the Situation After the War and How to Meet It. Edited by Huntly Carter. N. Y., E. P. Dutton and Co., 1918. 16 + 295 pp., 7 x 5 in., cloth. $2.00.

Contains the results of an inquiry undertaken to ascertain the opinions held by a large number of distinguished English men and women as to the probable industrial situation in Great Britain after the war and the best policy to be pursued by Labor, Capital, and the State. The views of statesmen, capitalists, labor leaders, economists, and others are included.

AN INTRODUCTION TO STATISTICAL METHODS:

A Textbook for College Students; A Manual for Statisticians and Business Executives. By Horace Secrist. N. Y., The Macmillan Company, 1917. 21 + 482 pp., 28 pl., 95 tab., 8 x 5 in., cloth. $2.00.

A study of the principles governing the collection, analysis, and synthetic treatment of numerical data, intended to supply the need for a fundamental treatment of the methods of statistical investigation and interpretation. The methods discussed are of general application, and are accompanied by illustrations drawn chiefly from economic and business fields. The treatment is non-mathematical.

ANALYSIS OF FINANCIAL STATEMENTS.

By Richard P. Wilson and Harry J. Carpenter. Chic., La Salle Extension University (copyright 1918). 38 pp., 4 illus., 9 x 6 in., paper.

Describes the methods and principles of these analyses, illustrating them by typical examples.

THE FINANCING OF PUBLIC SERVICE CORPORATIONS.

By Milton B. Ignatius. N. Y., The Ronald Press Company, 1918. 18 + 508 pp., 9 x 6 in., cloth. $5.00.

This volume presents a comprehensive discussion of all the important aspects of public service corporation financing from the inception of the enterprise to the expenditure of the proceeds. Intended for corporation officials, public officers, and bankers and brokers. Based on the work of the Public Service Commmission of the Second District of New York.

BOOKKEEPING AND COST ACCOUNTING FOR FACTORIES.

By William Kent. N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1918. 261 pp., illus., forms, tab., cloth, 11 x 8 in. $4.00.

The author has aimed to prepare a systematic treatise on cost accounting, which will start the student with the elementary principles of double-entry bookkeeping and lead him through factory accounting to cost accounting, giving him not only the fundamental theory in accordance with the views of the ablest modern accountants, but also warning him against the time-worn fallacies of the older school. Specific applications of the text to various industries are included.

A HISTORY OF CHEMISTRY.

By F. J. Moore. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1918. 14 + 292 pp., 6 illus., 12 pl., 37 por., 8 diag., 5 tab., 8 x 6 in., cloth. $2.50.

This volume is based on a course of lectures given to the senior students of chemistry in the Massachusetts Institute of Technology, and is intended to provide a concise account of those facts and influences which have made the science what it is to-day. Suitable for mature students.

A TEXT-BOOK OF INORGANIC CHEMISTRY.

Edited by J. Newton Friend. Vol. V: Carbon and Its Allies, by R. M. Caven. Lond., Charles Griffin & Co., Ltd.; Phila., J. B. Lippincott Co., 1917. 21 + 468 pp. 15 illus., 70 tab. (1 folded), 1 chart, 9 x 6 in., cloth. (Gift of J. B. Lippincott Co.)

The aim of this series is to provide a comprehensive text-book of inorganic chemistry, sufficiently complete for ordinary purposes and supplied with numerous references to the leading works and memoirs. Contents: Introductory; Carbon and Its Compounds; Silicon and Its Compounds; Titanium and Its Compounds; Zirconium and Its Compounds; Thorium and Its Compounds; Germanium and Its Compounds; Tin and Its Compounds; Lead and Its Compounds.

MODERN INORGANIC CHEMISTRY.

By J. W. Mellor. New ed. Lond. and N. Y., Longmans, Green and Co., 1917. 20 + 910 pp., 334 illus., 64 tab., 8 x 5 in., cloth. $2.50.

A general course in chemistry intended to develop skill in observation and experiment, memory and knowledge of relevant facts, ability to reason and think in a logical, systematic way, to cultivate the imagination, and to develop a critical and impartial judgment.

AN INTRODUCTION TO THE CHEMISTRY OF PLANT PRODUCTS.

By Paul Haas and T. G. Hill. 2d ed. Lond. and N. Y., Longmans, Green and Co., 1917. 12 + 411 pp., 5 illus., 9 x 6 in., cloth. $3.50.

This work is an attempt to provide botanists with an account of the chemical and biological significance of the more important substances occurring in plants. The present edition has been revised as a whole, and the section on plant pigments has been rewritten.

ORGANIC COMPOUNDS OF ARSENIC AND ANTIMONY.

By Gilbert T. Morgan. (Monographs on Industrial Chemistry.) Lond. and N. Y., Longmans, Green and Co., 1918. 20 + 376 pp., 9 x 6 in., cloth. $4.80.

This volume includes the methods of preparation and the chemical properties of those compounds, which have a practical application or theoretical interest. A useful bibliography is included.

SULPHURIC ACID HANDBOOK.

By Thomas J. Sullivan. N. Y., McGraw-Hill Book Company, Inc.; Lond., Hill Publishing Company, Ltd., 1918. 13 + 239 pp., 35 illus., 87 tab., 7 x 5 in., flexible cloth. $2.50.

The author has collected in one volume of convenient size the chemical and mechanical data of practical value to makers and users of sulphuric acid in American industries.

RUBBER:

Its Production, Chemistry, and Synthesis in the Light of Recent Research; A Practical Handbook for the Use of Rubber Cultivators, Chemists, Economists, and Others. By A. Dubosc and Dr. A. Luttringer. English Edition by Edward W. Lewis. Lond., Charles Griffin & Co., Ltd.; Phila., J. B. Lippincott Co., 1918. 11 + 383 pp., 51 tab., 9 x 6 in., cloth. $6.50. (Gift of J. B. Lippincott Co.)

The authors have collected into a single volume all the scattered writings relating to the cultivation or the modern chemistry of rubber, with the addition of their own observations on these subjects. Much attention is given to the various proposed processes for the synthesis of rubber.

EDIBLE OILS AND FATS.

By C. Ainsworth Mitchell. Lond. and N. Y., Longmans, Green and Co., 1918. 12 + 159 pp., 9 x 6 in., cloth. $2.00.

A concise outline of the chemical composition, and properties of the more important oils and fats, the methods of extracting them from the crude materials, and of purifying and preparing them for food. Particular attention is given to the newer methods. A very full bibliography is appended to the text.

PATENTING AND PROMOTING INVENTIONS.

By Moïs H. Avram. N. Y., Robert M. McBride & Co., 1918. 166 pp., 8 x 5 in., cloth. $1.50.

Written for the inexperienced inventor, this book gives sound practical advice on the proper methods of securing, protecting, and promoting commercial patents.

RADIOMETRIC APPARATUS

For Use in Psychological and Physiological Optics, Including a Discussion of the Various Types of Instruments That have been Used for Measuring Light Intensities. By C. E. Ferree and Gertrude Rand. (Published as Psychological Monographs, No. 103.) 16 + 65 pp., 6 illus., 10 x 7 in., paper. 75 cents. (Gift of C. E. Ferree.)

After a discussion of the various types of instruments that have been used for measuring light intensities, and the advantages and disadvantages of each, the authors describe the apparatus which they have found most desirable.

MANUAL OF FORESTRY FOR THE NORTHEASTERN UNITED STATES:

Being Vol. I of "Forestry in New England" Revised. By Ralph Chapman Hawley and Austin Foster Hawes. 2d ed. N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1918. 12 + 281 pp., 64 illus., 80 tab., 9 x 6 in., cloth. $2.00.

The first of two volumes dealing with the specific forestry problems of New England, but applicable also to conditions in neighboring States. This volume presents, in the simplest and least technical form possible, a brief survey of the whole field of forestry, for the use of woodland owners.

A HANDBOOK OF ROCKS

For Use Without the Microscope; with a Glossary on the Names of Rocks and of Other Lithological Terms. By James Furman Kemp. 5th ed., rev. N. Y., D. Van Nostrand & Co., 1918. 11 + 272 pp., 41 illus., 75 tab., 10 x 6 in., cloth. $1.50.

Prof. Kemp has attempted to avoid the difficulties usually met by students, by mentioning and emphasizing only those characteristics which a beginner with preliminary training in mineralogy can observe and grasp. The fifth edition has been revised and enlarged, and an extensive glossary is included in the work.

MacRAE'S BLUE BOOK:

America's Greatest Buying Guide. Vol. IX, 1918. Chic., McRae's Blue Book Company (copyright 1918). 1345 pp., 12 x 9 in., cloth. $10.00.

This directory contains a list of thirty thousand American manufacturers of machinery, tools, and other supplies used by railroads and manufacturers, a list of manufacturers' representatives, a classed directory of makers of different products, an index of trade names, a collection of data useful to purchasing agents, tables of standard prices, and a discount computer.

A BIBLIOGRAPHY OF MUNICIPAL UTILITY REGULATION

And Municipal Ownership. By Don Lorenzo Stevens. Cambridge, Harvard University Press, 1918. 410 pp., 9 x 6 in., cloth. $4.00.

An extensive bibliography of material published in English, brought down to the end of 1916. Covers electric, gas, water, and traction utilities, listing the material which the author considers of practical value, after an extensive study of the field. The entries are classified and annotated, and an index of subjects and authors is provided.

WAR ADJUSTMENTS IN RAILROAD REGULATION.

Edited by C. H. Crennan. (Annals of the American Academy of Political and Social Science, Vol. 76, Whole Number, 165, March, 1918.) Phila., The American Academy of Political and Social Science, 1918. 10 + 333 pp., 10 x 7 in., paper. $1.00.

In this number is presented a discussion, by a number of railroad men, political economists, and lawyers, of various problems connected with railroad regulation. The principal headings are: Railroad Regulation on Trial; War Pressure for Adequate Service; Present Effects of War Control of Railroads; Plans for Adjustment after the War; Continuing Problems of Public Policy; Documents and Statistics Pertinent to Current Railroad Problems.

REGULATION OF RAILWAYS;

Including a Discussion of Government Ownership Versus Government Control. By Samuel O. Dunn. N. Y. and Lond., D. Appleton and Co., 1918. 10 + 354 pp., 5 tab., 8 x 5 in., cloth. $1.75.

A general presentation of the methods that have been advocated and of the actual effects of rate regulation. Contents: What is the Matter with Railway Regulation? Functions of Government in Relation to Railways; Commission *versus* Legislative Regulation; Federal *versus* State Regulation; Regulation of Rates; Valuation in Relation to Regulation of Rates and Securities; Regulation of Securities; Regulation of Railway Operation; Peaceful Settlement of Labor Disputes, or Strikes? Government Regulation *versus* Government Ownership; Some Practical Phases of Government Ownership; The Failure of Government Ownership in Canada.

AMERICAN RAILWAY ACCOUNTING:

A Commentary. By Henry C. Adams. N. Y., Henry Holt & Co., 1918. 10 + 465 pp., 8 x 5 in., cloth. $3.00.

Discusses the standard system of railway accounts promulgated for and used by American railways, and is intended to explain the accepted rules to students of accounting and practical accountants. Contents: The Task of the Railway Accountant; Structure of a System of Railway Accounts; Construction Costs Prior to Operation; Construction Accounts Subsequent to Operation; Operating Expenses; Operating Revenues; The Income Account; Profit and Loss Accounts; General Balance Sheet Accounts; Classification of Investments in Road and Equipment; Classification of Operating Revenues and Operating Expenses; Classification of Income; Profit and Loss; Balance Sheet Accounts.

TRAIN OPERATION:

A Treatise on Train Rules, Train Orders, Change of Time Table, Automatic Block Signals, Interlocking, Examination Questions and Answers. By William Nichols. Rochester, N. Y., Le Grand Brown, 1916. 18 + 340 pp., 44 illus., 55 pl., flexible leather. $2.50. (Flexible cloth, $2.00.)

An interpretation and amplification of the rulings of the American Railway Association issued prior to November, 1915, and of the Standard Train Rules, and other practices which have been found necessary in handling trains. Based on the author's experience as Chairman, Board of Examiners, Southern Pacific Company, but does not apply to any particular railroad.

MODERN LOCOMOTIVE VALVES AND VALVE GEARS.

By Charles L. McShane. Chic., Griffin & Winters, 1918. 339 pp., 113 illus., 1 folded pl., 8 x 5 in., cloth. $2.50.

A practical discussion of the principles, construction, and operation of the valves and valve gears of modern locomotives. Written in simple, non-mathematical language.

A TREATISE ON ROADS AND PAVEMENTS.

By Ira Osborn Baker. 3d ed., re-written and enl. N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1918. 11 + 666 pp., 235 illus., 83 tab., 9 x 6 in., cloth. $4.50.

Dr. Baker's work is a discussion of the engineering principles involved in the construction of country roads and city pavements, intended for the designer and inspector, rather than for the contractor. Attention has been given to materials and forms of construction that affect the quality and cost of roadway, rather than to methods of doing the work. This third edition has been thoroughly revised and entirely rewritten. Five chapters of minor importance have been dropped to make room for an equal number of new ones, and the number of illustrations has been greatly increased.

ELEMENTS OF SANITARY ENGINEERING.

By Mansfield Merriman. 4th ed., rev. with the Assistance of Richard M. Merriman. N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1918. 250 pp., 47 illus., 17 tab., 9 x 5 in., cloth. $2.00.

A textbook intended to present the subject clearly in the smallest possible space, and to give greater prominence to fundamental principles than to details of construction and operation. The present edition has been revised, and fourteen new pages of text have been added.

EYE HAZARDS IN INDUSTRIAL OCCUPATIONS:

A Report of Typical Cases and Conditions, with Recommendations for Safe Practice. By Gordon L. Berry. N. Y., National Committee for the Prevention of Blindness, 1917. 145 pp., 51 illus., 9 x 6 in., paper. 50 cents.

A survey of the hazards to the eyes in industrial occupations in the United States, with recommendations and suggestions for minimizing them.

DISEASES OF OCCUPATION AND VOCATIONAL HYGIENE.

Edited by George M. Kober and William C. Hanson. Phila., P. Blakiston's Son and Co. (copyright 1916). 21 + 918 pp., 46 illus., 10 x 6 in., cloth. $8.00.

With the assistance of a large number of experts, the editors have endeavored to present the basic facts concerning diseases of occupation in such a way as to form a safe, convenient guide for physicians, employers, workmen, legislators, public health officials, and other interested persons.

HEATING AND VENTILATION.

By John R. Allen and J. H. Walker. N. Y., McGraw-Hill Book Company, Inc.; Lond., Hill Publishing Company, Ltd., 1918. 10 + 305 pp., 174 illus., 76 tab., 9 x 6 in., cloth. $3.00.

Intended for use as a textbook in schools of engineering and architecture, and as a handbook by practicing engineers.

CONCRETE ENGINEERS' HANDBOOK;

Data for the Design and Construction of Plain and Reinforced Concrete Structures. By George A. Hool and Nathan C. Johnson, Assisted by S. C. Hollister, with Chapters by Harvey Whipple, Adelbert P. Mills, Walter S. Edge, A. G. Hillberg, and Leslie H. Allen. N. Y., McGraw-Hill Book Company, Inc.; Lond., Hill Publishing Company, Ltd., 1918. 23 + 885 pp., illus., pl., tab., diag., 9 x 6 in., flexible cloth. $5.00.

This work has been prepared to make available in concise form the best present knowledge concerning concrete and reinforced concrete, and to present complete data and details, as well as numerous tables and diagrams, for the design and construction of the principal types of concrete structures.

STRENGTH OF MATERIALS:

A Comprehensive Presentation of Scientific Methods of Locating and Determining Stresses and Calculating the Required Strength and Dimensions of Building Material. By Edward R. Maurer. Chic., American Technical Society, 1918. 126 pp., 2 pl., 7 tab., 8 x 5 in., cloth. $1.00.

An elementary presentation of the subject, in which the use of higher mathematics has been avoided.

OVER THE DRAWING BOARD:

A Draftsman's Hand Book. By Ben J. Lubschez. Washington, D. C., Journal of the American Institute of Architects, 1918. 10 + 131 pp., 22 illus., 9 pl., 7 x 5 in., cloth. $2.00. (Gift of Author.)

From his experience and observation, the author has selected convenient methods and short-cuts for draftsmen. Contents: Introductory; Drafting Room; Equipment; Instruments; Mounting of Paper and Drawings; Tracing Paper and Tracing Cloth; Geometrical Short-Cuts; Lettering; Titling; Numbering; Working Drawings; Indications; Lines; Sketches; Exhibition Drawings; Water Colors; Perspective; Filing of Drawings and Plates; Photography; The Reproductive Processes; Photo-Engraving; Etching; Wood Engraving; Lithography.

ENGINEERING FOR MASONRY DAMS.

By William Pitcher Creager. N. Y., John Wiley and Sons, Inc.; Lond., Chapman and Hall, Ltd., 1917. 11 + 237 pp., 88 illus., 1 pl., 25 tab., 9 x 6 in., cloth. $2.50.

The author presents the theory and the fundamental assumptions of design of dams of this type, and gives a number of examples showing the application of theory to practical designing. Contents: Investigations and Surveys: The Choice of Type of Dam; Forces Acting on Dams; Requirements for Stability of Gravity Dams; General Equations for Design of Gravity Dams; The Design of Solid, Non-Overflow Gravity Dams; The Design of Solid Spillway Gravity Dams; The Design of Hollow Dams; The Design of Arch Dams; Preparation and Protection of the Foundation; Flood Flows; Details and Accessories.

PRINCIPLES OF OCEAN TRANSPORTATION.

By Emory R. Johnson and Grover G. Huebner. N. Y. and Lond., D. Appleton and Co., 1918. 21 + 513 pp., 68 illus., 3 folded pl., 9 maps (2 folded), 2 folded charts, 18 tab., 9 x 6 in., cloth. $2.50.

A systematic, comprehensive review of the whole subject, including ocean couriers and their services, ocean conferences, ocean rates and fares, and the principles and practices of government aid and regulation of ocean shipping. The book does not attempt to treat the various questions exhaustively, but seeks to present the essential facts for students and business men.

ROLL OF HONOR

A List of Members of the Society Who are Serving in the Army or Navy of the United States or Any of Its Allies.*

VANSITTART, GEORGE EDWARD. *Maj., 13th Battery, Canadian Field Artillery, 2d Canadian Div.: wounded in action (France); died May 14th, 1916.*

AGNEW, AUGUSTUS WATEROUS. *Capt., 3d Canadian Pioneers; wounded in action (France); died September 17th, 1916.*

HAGUE, WILLIAM. *1st Lieut., Engr. R. C., 116th Engrs.: died in service (France), January 1st, 1918.*

GOODFELLOW, JAMES GORDON. *Maj., Royal Engrs.: killed in action (France), March 23d, 1918.*

BUCKWALTER, DANIEL HARRIS. *Capt., Engr. R. C.: killed in action (France), May 12th, 1918.*

LINDBERY, CHARLES ARTHUR. *Capt., Engr. R. C.; died in service (Camp Lee, Va.).*

Abbot, Frederic V. Brig.-Gen., Corps of Engrs., N. A.

Abbot, Frederick William. Lt.-Col., British Army.

Acher, A. H. Maj., Corps of Engrs., U. S. A.; Acting Lt.-Col., 4th Engrs., A. E. F., France.

Acker, Robert L. Corporal, Headquarters Co., 7th Field Artillery, A. E. F., France.

Ackerman, Alexander S. Capt., Engr. R. C., A. E. F., France.

Ackerman, Arthur P. 1st Lieut., Engr. R. C., 517th Engrs.

Adams, Arthur. Maj., Ord. R. C.

Adams, Edward M. Maj., U. S. A.

Adams, Milton Jewell. Capt., Engr. R. C., Co. C, 114th Engrs.

Adams, Raymond E. Capt., Q. M. R. C.

Albert, Frederick W. Lt.-Col., Engrs., N. A.

Alden, Herbert C. 1st Lieut., C. A. C., N. G. U. S.

Alden, Langford Taylor. Aspirant, 7^{e} Batterie, 51st Regt. d'Artillerie, Secteur Postal No. 82 (French Army); Care, Morgan, Harjes Cie., Boulevard Haussmann, Paris, France.

Alexander, E. Porter. 1st Lieut., Engr. R. C., 509th Engrs., A. P. O. 701, A. E. F., France.

Alexander, Kay. Maj., 2d in Command, 12th Canadian Ry. Troops, B. E. F., France.

Allen, Franklin R. Capt., Engr. R. C.

Allen, Herschel Heathcote. Capt., Engr. R. C.

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* This list is made up from replies to a circular forwarded to members of the Society, and others, and is probably neither accurate nor complete. It is requested that the attention of the Secretary be called to any omissions or inaccuracies in order that they may be corrected in subsequent lists.

Allen, Ralph B. 1st Lieut., Engr. R. C., Co. B, 25th Engrs., A. E. F., France.

Allen, Walter Henry. Maj., Engr. R. C.

Allen, Walter Hinds. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Allison, William F. Maj., Engr. R. C., A. E. F., France.

Altman, Frank S. Lieut., Engr. R. C., 23d Engrs.

Altstaetter, F. W. Col., Corps of Engrs., U. S. A.

Anderson, J. E. Maj., 212th Field Co., Royal Engrs., B. E. F., France.

Anderson, J. H. Capt., Engr. R. C.; Adjt., 1st Replacement Engrs.

Anderson, W. P. Capt., Engr. R. C., A. E. F., France.

Anderson, W. S. Cadet, School of Military Aeronautics.

Andrew, Clarence R. Capt., Engr. R. C., 32d Engrs.

Andrews, Carl B. Capt., Engr. R. C.

Andrews, J. H. M. Maj., Ord. R. C.

Angas, Robert M. 1st Lieut., U. S. N. G., 106th Engrs.

Annear, E. H. Capt., Engr. R. C., 20th Engrs.

Applegarth, Gault. Capt., Engr. R. C., 23d Engrs.

Ardery, Edward Dahl. Col., Corps of Engrs., U. S. A.; Chf. Gas Officer, 2d Army Corps, A. E. F., France.

Armitage, George W. Capt., Q. M. R. C.

Arms, Leo M. Lieut., Engr. R. C., Co. F, 2d Engrs., A. E. F., France.

Armstrong, Charles Johnstone. Brig.-Gen.; Chf. Engr., H. Q., Canadian Army Corps, B. E. F., France.

Armstrong, Merwin. Capt., Engr. R. C., 105th Engrs.

Arn, William G. Maj., Engrs., N. A., 13th U. S. Engrs. (Ry.), Postal Sector 215, A. E. F., France.

Ashkins, Nathan Thomas. 1st Lieut., Engr. R. C., Lines of Communication, Eng. Headquarters, A. E. F., France.

Ashley, Carl. Capt., Engr. R. C., U. S. Military P. O. 702, A. E. F., France.

Ashmead, P. H. Maj., Engr. R. C.

Ashton, Raymond. 2d Lieut., A. S., Sig. R. C., A. E. F., France.

Asplundh, E. T. Capt., Engr. R. C.; Supply Officer, 103d Engrs.

Asserson, Henry Raymond. Maj., Engr. R. C., C. E. L. O. C., A. E. F., France.

Atterbury, W. W. Brig.-Gen.; Director of Transportation, A. E. F., France.

Atwood, William G. Lt.-Col., Engrs., N. A., 17th Engrs. (Ry.), U. S. A. P. O. 701, A. E. F., St. Nazaire, France.

Austill, Hurieosco. Capt., Engr. R. C., Co. D, 501st Engr. Service Bn., A. E. F., France.

Austin, H. A. R. 1st Lieut., Engr. R. C.

Ayres, John Henry. Capt., Engr. R. C., Co. D, 42d Engrs.

Ayres, Quincy C. 2d Lieut., Engr. R. C., A. E. F., France.

Babbitt, Harold E. Capt., Engr. R. C., Chf. Engr.'s Office, Adv. Sect. S. O. S., U. S. P. O. No. 714, A. E. F., France.

Baffrey, Charles R. Capt., 102d Reg. d'Artillerie (French Army), Secteur Postal 160, B. C. M., Paris, France.

Bailey, Lewis P. Capt., Engr. R. C., Co. A, 304th Engrs.

Bakenhus, R. E. Civ. Engr., U. S. N. (rank of Commander).

Baker, George L. 1st Lieut., Inf., N. A.

Baker, H. S. Lt.-Col., Engrs., N. A., 111th Engrs.

Baker, Shirley. Capt., Engr. R. C., Co. B, 23d Engrs.

Balch, William H. Capt., Engr. R. C., A. P. O. 712, A. E. F., France.

Barber, Charles W. Private, 38th U. S. Engrs.

Barber, Justin F. Sergeant, Co. M, 23d Engrs., A. E. F., France.

Barber, Norman N. Capt., N. A., 16th Engrs., A. E. F., France.

Barclay, A. J. 1st Lieut., Engr. R. C.

Barney, Samuel E. Maj., Engr. R. C. (*Unassigned*).

Bartholomew, B. W. Lieut., Engr. R. C., 301st Engrs.

Bascom, George R. Maj., San. C., N. A.

Bassett, Herbert H. Maj., Engr. R. C.

Battie, H. S. 1st Lieut., Engr. R. C.

Baxter, O. G. Capt., Engr. R. C., Co. C, 601st Engrs.

Bayliss, Paul. 2d Lieut., Engr. R. C., 8th Engrs. (Mounted).

Beach, Lansing H. Col., Corps of Engrs., U. S. A.

Beall, Pendleton. Private, Headquarters Co., 165th Inf., A. E. F., France.

Beam, Carl Eugene. 2d Lieut., Engrs., N. A.

Bebb, Edward C. Capt., Engr. R. C.

Beeman, Thomas R. Capt., Engr. R. C., A. E. F., France.

Beerbower, Dumont. Capt., Engrs., N. A., Co. C, 535th Engrs.

Begg, R. B. H. Capt., Engr. R. C., A. E. F., France.

Behrman, I. E. 1st Lieut., Engr. R. C., Care, C. E. O., Zone of the Advance, A. E. F., France.

Belknap, Francis W. Engr. R. C., U. S. Army P. O. 705, A. E. F., France.

Bell, George Edward. Lieut., Canadian Engrs., Care, Bank of Montreal, Waterloo Pl., London, S. W., England.

Bell, Harry W. Capt., Engr. R. C.

Bellinger, L. F. Civ. Engr., U. S. N. (rank of Commander).

Benham, Claude Gilbert. Capt., C. A. C., U. S. A.

Benham, W. L. Maj., Q. M. R. C.

Bennett, John W. F. Maj., Q. M. C., N. A.

Bennison, Ernest William. 1st Lieut., Engr. R. C., 23d Engrs.

Bensel, J. A. Maj., Engr. R. C.

Benson, Orville. Maj., Engr. R. C., Headquarters, A. E. F., France.

Berdeau, Ray W. Capt., Engr. R. C.

Bergan, Thomas B. Lieut., N. A.

Betts, Clifford A. 1st Lieut., C. A. R. C., Battery E, 52d Artillery, A. E. F., France.

Biddle, John. Maj.-Gen., Corps of Engrs., U. S. A.

Billings, A. W. K. Lt.-Commander, Care, Commander, U. S. Naval Aviation Forces, Paris, France.

Billings, Fred M. Capt., Engr. R. C.

Binckley, George Sydney. Maj., Engr. R. C., 112th Engrs.

Binger, Walter D. 2d Lieut., Sig. R. C.

Birdseye, Claude H. Maj., Engr. R. C., Coast Artillery Brigade, A. E. F., France.

Bishop, Roy P. 2d Lieut., Engr. R. C., 35th Engrs., A. P. O. 735, A. E. F., France.

Bither, T. A. 2d Lieut., Sig. R. C., A. S.

Bixby, William H. Brig.-Gen., U. S. A. (*Retired*).

Black, Dudley F. Capt., Engr. R. C., 513th Engrs., A. E. F., France.

Black, G. G. Capt., Engr. R. C.; Acting Adjt., 314th Engrs.

Black, James B. 1st Lieut., Engr. R. C., Chf. Engr.'s Office, Headquarters, A. E. F., France.

Black, Ralph P. 1st Lieut., Engr. R. C., 32d Engrs.

Black, Roger Derby. Lt.-Col., Corps of Engrs., U. S. A., Headquarters, A. E. F., France.

Black, William M. Maj.-Gen.; Chf. of Engrs., U. S. A.

Blackman, J. W. B. Lieut., Canadian Ry. Troops, C. E. F.

Blair, Alexander. 2d Lieut., Royal Engrs., B. E. F., France.

Blair, McCrea Parker. Capt., No. 1 Depot Bn., Manitoba Regt., Winnipeg, Man., Canada.

Blanchard, Murray. Maj., Engr. R. C., 520th Engrs.

Boesch, Clarence E. Capt., U. S. N. G., Co. B, 105th Engrs.

Boggs, F. C. Col., 315th Engrs., N. A.

Boland, Charles J. 1st Lieut., Sig. C., U. S. A., 80th Aero Squadron, A. E. F., France.

Bolin, Harry W. Sergeant, Co. E, 23d Engrs.

Bolton, Frank L. Capt., Engr. R. C., 20th Engrs.

Bond, P. S. Col., 107th Engrs., N. A.; Div. Engr., 32d Div., Army Engr. School, U. S. P. O. 714, A. E. F., France.

Bonner, John P. Capt., C. A. R. C., A. E. F., France.

Boorman, Kitchell M. Lieut., Sig. C., U. S. A., 481st Aero Squadron, A. E. F., France.

Booth, Raymond. 1st Lieut., Engr. R. C., 54th Engrs.

Booz, Horace Corey. Col., R. T. C., N. A., Care, D. G. T., A. E. F., France.

Bosche, Guy. Capt., Engr. R. C., M. P. O. 705, A. E. F., France.

Bott, C. N. 1st Lieut., Engr. R. C., 312th Engrs.

Bowen, Edward Withers. Capt., Inf. R. C., 2d Inf. Replacement Regt.

Bowlby, Henry L. Maj., 43d Engrs., N. A.

Bowles, James T.-B. Maj., San. C., N. A.

Bowne, Sidney B. 2d Lieut., U. S. Public Health Service.

Boyd, George R. Capt., Engr. R. C., A. E. F., France.

Boyden, Harry C. Maj., Engrs., N. A.

Boyle, James M. Maj., Ord. R. C.

Bragg, Kendal B. Asst. Civ. Engr. (rank of Lieut. (Junior Grade)).

Braly, Raymond F. 1st Lieut., Engr. R. C.

Braunworth, Percy L. Capt., Engr. R. C., Care, Director General of Transportation, Army P. O. 705, A. E. F., France.

Bres, Edward Sedley. 1st Lieut., Engr. R. C., 114th Engrs.

Brewster, Henry B. Capt., Engr. R. C., and Adjt., 303d Engrs.

Breymann, John B., Jr. 2d Lieut., C. A. R. C., 22d Co.

Briggs, Robert W. Lieut., Sig. R. C., A. S., 73d Aero Constr. Squadron.

Bright, Graham B. Capt., Engr. R. C., and Regimental Adjt., 305th Engrs. (Pioneers).

Brinkley, Milo H. Capt., Engr. R. C.

Bronson, Howard F. Capt., San. C., N. A.

Brook, A. E. Capt., Royal Engrs., B. E. F., France.

Brooking, J. H. Capt., Engr. R. C., Co. B, 12th Engrs. (Ry.), A. E. F., France.

Brooks, Josiah R. 1st Lieut., Engr. R. C.

Brown, Charles E. Capt., Engr. R. C.

Brown, Clarence C. 1st Lieut., Co. E, 12th Engrs. (Ry.), A. E. F., France.

Brown, Earl I. Col., 317th Engrs.

Brown, Elliot C. Lt.-Commander, U. S. N. R.

Brown, H. Whittemore. 2d Lieut., Engr. R. C., A. E. F., France.

Brown, Harry Madara. 1st Lieut., Inf. R. C. (*Unassigned*).

Brown, Levant R. Capt., Engr. R. C.

Brown, Marshall W. Maj., Engr. R. C., P. O. 702, A. E. F., France.

Brown, Norman F. Maj., R. T. C., N. A., Care, Director-Gen. of Transportation, A. E. F., France.

Brown, Robert H. Capt., San. C., N. A.

Brownell, E. H. Civ. Engr., U. S. N. (rank of Commander).

Brush, Carl F. Capt., Engr. R. C., A. P. O. 716, A. E. F., France.

Bryan, Clark A. Capt., Engr. R. C.

Buchanan, Warren Henderson. Chf. Machinist Mate, U. S. N. R. F.

Bucher, Harold F. Lieut., Engr. R. C., 2d Engrs., A. E. F., France.

Buck, Richard S. Maj., 11th Engrs. (Ry.), A. E. F., France.

Buck, Walter Van. Capt., Engr. R. C., Co. F, 23d Engrs.

Bunker, George H. Capt., Engr. R. C., 306th Engrs.

Bunker, Stephen S. Capt., Engr. R. C., Co. C, 503d Service Bn., A. E. F., France.

Burd, Edward M. Capt., C. A. R. C.

Burdett, O. L. Capt., Engr. R. C., A. E. F., France.

Burger, Alfred A. 2d Lieut., Inf. N. A., 19th Co., 2d Inf. Replacement Regt.

Burgess, Harry. Col., N. A., 16th Engrs. (Ry.), A. E. F., France.

Burkett, Joseph M. Capt., Engr. R. C., A. E. F., France.

Burky, C. R. Capt., Sig. R. C., A. S.

Burr, Edward. Col., Corps of Engrs., U. S. A., Manila, Philippine Islands.

Burrell, Glenn S. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Burrowes, H. G. 1st Lieut., Engr. R. C., Co. B, 25th Engrs., A. E. F., France.

Burt, Henry J. Maj., Q. M. C., N. A.

Burton, William. 1st Lieut., Engr. R. C.

Bush, Lee M. Central Officers' Training School, Camp Zachary Taylor, Ky.

Bush, Lincoln. Lt.-Col., Q. M. C., N. A.

Bushnell, Howard B. Capt., Engr. R. C., A. E. F., France.

Bushnell, Howard E. Capt., Engr. R. C.

Busse, Franz A. Capt., Engr. R. C. (*Unattached*), A. E. F., France.

Butler, John Soule. Maj., Engr. R. C.

Butler, Millard A. Col., Q. M. C., N. A.

Butler, William P. Lieut., U. S. N. R. F.

Byam, L. H. Capt., Engr. R. C.

Byllesby, Henry M. Maj., Sig. R. C., A. S.

Byrd, J. H. Capt., Engr. R. C., 314th Engrs.

Caffall, Geoffrey A. Private, No. 1 Coy., Canadian Machine Gun Depot, Seaford, Sussex, England.

Caldwell, William H. Lieut., U. S. N. R. F.

Cameron, Harry Frank. Maj., Engr. R. C.

Camp, George Dashiell. 1st Lieut., Engr. R. C., 316th Engrs.

Campbell, Charles C. Private, Co. No. 13, Motor Group, Med. C.

Canfield, George Hathaway. Capt., Engr. R. C., 316th Engrs.

Carey, Matthew L. Capt., Q. M. R. C., A. E. F., France.

Carey, William N. Maj., 1st Bn., 313th Engrs.

Carlin, J. P. Capt., Engr. R. C.

Carlson, Carl Alexius. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Caro, Phillip. Lieut., 2d Junior Co., No. 4 Command Depot, A. T. F., Codford, Wiltshire, England.

Carroll, James E. Maj., Engr. R. C., 527th Engrs., A. P. O. 701, A. E. F., France.

Carter, E. Kemper. Capt., Engr. R. C., Co. C, 518th Engrs.

Case, Charles A. 1st Lieut., Engr. R. C., 314th Engrs.

Cate, Charles Edward. Capt., 45th Engrs., N. A.

Caton, John H., 3d. Capt., Engr. R. C.

Cattell, William A. Maj., Engr. R. C.

Cerny, John W. Maj., Q. M. C., N. A.

Chadwick, Maurice F. Private, 24th Tr. Bn., F. A. R. D., Camp Jackson, S. C.

Chamberlaine, Robert L. Capt., A. S., Sig. R. C.

Chambers, Frank T. Civ. Engr., U. S. N. (rank of Captain).

Chandler, William E. Master Gunner, Headquarters Co., 55th Artillery, C. A. C., A. P. O. 723, A. E. F., France.

Chapman, Mellville D. Lieut., U. S. Marine Corps.

Chase, Clifford E. Capt., Engr. R. C., Co. A, 4th Engrs.

Cheney, Sherwood A. Col., N. A., 110th Engrs., A. E. F., France.

Cherry, Alan Gordon. 1st Lieut., N. A., 301st Engrs.

Chevalier, Willard T. Capt., Engr. R. C., Co. D, 11th Engrs. (Ry.), A. E. F., France.

Child, John T. 2d Lieut., San. C., N. A.

Chittenden, Albert Frederick. 1st Lieut., Engr. R. C., Co. F, 18th Engrs. (Ry.), P. O. No. 705, A. E. F., France.

Christensen, George A. Capt., Q. M. R. C.

Christophers, Reginald Gillon. (No. 60286), 2d Lieut., 34th Reinforcements, N. Z. E. F.

Church, Elihu C. Capt., Engr. R. C., A. E. F., France.

Churchill, Percival M. Maj., Engr. R. C., Headquarters, 538th Engrs.

Churchill, Robert C. Lieut., Co. D, 25th Engrs., A. E. F., France.

Claflin, William B. Capt., Engr. R. C., Headquarters, 39th Div.

Claiborne, Herbert A., Jr. 2d Lieut., Sig. R. C. (*Unassigned*).

Clark, Ernest A. Capt., Engr. R. C.

Clark, Howard F. Capt., Engr. R. C., A. E. F., France.

Clarke, Harry L. 1st Lieut., Engr. R. C., Co. E, 28th Engrs., N. A.

Clarke, Thomas C. Lt.-Col., 110th Engrs., A. E. F., France.

Clarke, W. D. Capt., Engr. R. C., 23d Engrs. (Highway), A. E. F., France.

Clayton, Thomas W. Capt., Engr. R. C., A. E. F., France.

Cleckner, Frederick M. Private, Meteorological Section, Sig. C.

Cleveland, Lou B. 1st Lieut., Co. D, 105th Engrs.

Clinton, Delmar S. Maj., Engr. R. C.

Cobb, William R. Lieut., U. S. N. N. V., U. S. S. *Frederick*.

Cochrane, Victor Hugo. Maj., Q. M. C., N. A.

Coe, C. S. Maj., Engrs. N. A., 17th Engrs. (Ry.), A. P. O. 701, A. E. F., France.

Coe, David. Acting Capt., R. E., Care, R. C. E., Communications, B. E. F., France.

Coe, E. K. Maj., Engr. R. C., Care, C. E. O., L. of C., U. S. M. P. O. No. 702, A. E. F., France.

Cole, Howard J. Capt., Engr. R. C.

Coleman, Eugene H. Capt., Engr. R. C., 312th Engrs.

Colgan, R. J. Capt., 11th Engrs. (Ry.), A. E. F., France.

Collins, Earl H. Capt., C. A. R. C.

Collins, Merton C. 1st Lieut., Engr. R. C.

Columbia, Curtis F. 1st Lieut., C. A. R. C., Heavy Artillery Headquarters, A. E. F., France.

Comly, Harry S. Meteorologist, Sig. C, 32d Service Co., Meteorological Section, U. S. A.

Comly, James R. 1st Lieut., Engr. R. C., 55th Engrs.

Compton, Arthur M. Lt.-Col., 126th F. A.

Compton, R. Keith. Maj., Engr. R. C.

Conard, Clarence Knight. Maj., Ord. R. C.

Conard, R. A. Civ. Engr., U. S. N. R. F., Port au Prince, Haiti.

Connelly, Walter L. Master Engr., Senior Grade, Headquarters Det., 310th Engrs.

Connolly, A. H. Cadet, School of Military Aeronautics.

Connor, W. D. Col., N. A., Gen. Staff; Asst. Chf. of Staff, A. E. F., France.

Conway, N. B. Capt., Engr. R. C., 516th Engrs.

Cook, Paul D. Capt., Engr. R. C., 109th Engrs.

Cooke, Frederick H. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Coombs, Robert D. Maj., Ord. R. C.

Coomer, R. M. Capt., Engr. R. C., Headquarters, Eng. Corps, Line of Communications, A. E. F., France.

Cooper, David R. Capt., Engr. R. C., A. E. F., France.

Cooper, Hugh L. Lt.-Col., N. A., A. E. F., France.

Copeland, Robert Morris. 2d Lieut., Engr. R. C.; Instr., 111th Engrs.

Corkran, Wilbur Sherman. Capt., Engrs., U. S. A., Co. A, 1st Engrs., A. E. F., France.

Cornell, J. W. Capt., Q. M. C., N. A.

Cornish, Lorenzo D. Capt., Engr. R. C., Co. C, 15th Engrs. (Ry.), A. E. F., France.

Cosby, Spencer. Col., Corps of Engrs., U. S. A., 5th Engrs.

Cotter, Carl Henry. Asst. Civ. Engr., U. S. N.

Covert, John F. 1st Lieut., Engr. R. C.

Cowles, William Pierce. Maj., Engr. R. C., 34th Engrs., A. E. F., France.

Cox, Leonard M. Civ. Engr., U. S. N. (rank of Commander).

Coy, Burgis G. Capt., Engr. R. C., Co. D, 314th Engrs.

Cragin, Charles Calhoun. Capt., Co. C, 18th Engrs. (Ry.), A. E. F., France.

Crandall, Carl. Flying Cadet, U. S. Air Service.

Crane, Albert Eli. 1st Lieut., Engr. R. C., 6th Engrs., A. E. F.. France.

Crane, Joseph S. Maj., Q. M. C., N. A.

Crawford, Hugh W. Capt., Co. A, 110th Engrs.

Crawford, Ivan C. Maj., U. S. N. G., 115th Engrs.

Crecelius, S. F. Lt.-Col., Engr. R. C., 101st Engrs., A. E. F., France.

Crocker, Herbert Samuel. Maj., Engr. R. C.

Crocker, James R. Capt., Engr. R. C., Co. F, 106th Engrs.

Crooks, Clinton H. Capt., Engr. R. C.

Crosby, W. W. Lt.-Col., Engrs., N. A.

Crowell, Francis S. Capt., Q. M. C., N. A.

Crozier, William. Maj.-Gen., U. S. A.; Chief of Ordnance, U. S. A.

Cudebec, Albert B. Capt., Engr. R. C., U. S. Military P. O. No. 702, A. E. F., France.

Culver, Arthur. Lieut., R. E., 156th Field Co., B. E. F., France.

Cunningham, John G. L. Capt., Ord. R. C.

Curfman, Lawrence E. Maj., Engr. R. C., 314th Engrs.

Currey, J. W. 1st Lieut., Engr. R. C., Co. C, 115th Engrs.

Currie, Thomas A., Jr. Private, Co. D, 301st Inf.

Cushing, Edward B. Maj., Engr. R. C.; Supt., Army Transport Service, U. S. A. P. O. No. 705, A. E. F., France.

Cutler, Leon G. Capt., C. A. R. C., 57th Artillery, C. A. C., A. E. F., France.

Dallis, Park A. Capt., Engr. R. C.; Adjt., 24th Engrs.

Daly, A. P. V. 2d Lieut., 4th Connaught Rangers; 48 Cathcart Rd., London, S. W., England.

Daly, D. A. Capt., Engr. R. C., 16th Engrs., A. E. F., France.

Daly, John W. Lieut., Inf. R. C.

Danforth, George Clapp. Capt., Engr. R. C., 602d Engrs., A. E. F., France.

Darling, Clinton Stowell. 1st Lieut., 108th Engrs., A. E. F., France.

Darville, M. A. 2d Lieut., Engr. R. C., A. E. F., France.

Davidson, George B. 2d Lieut., Engr. R. C.

Davies, J. P. Capt., Ord. R. C.

Davis, Chandler. Capt., Engr. R. C., A. E. F., France.

Davis, Daniel E. 1st Lieut., Engr. R. C.

Davis, Frederick A. W. 1st Lieut., Co. E, 102d Engrs.

Davis, John C. Capt., C. A. R. C.

Davis, Robert M. 1st Lieut., Engr. R. C., 57th Engrs. (Inland Waterways).

Davy, J. J. 1st Lieut., 23d Engrs.

Day, Warren E. Capt., Engr. R. C.

Dean, Bertram D. Capt., Engr. R. C., Dept., C. and F., Headquarters, S. O. S., U. S. M. P. O. 717, A. E. F., France.

Dean, Willis J. 1st Lieut., Q. M. C., N. A.

de Charms, Richard, Jr. 1st Lieut., Engr. R. C., Co. A, 503d Engrs. (Service Bn.), A. E. F., France.

Dedicke, E. C. 2d Lieut., U. S. A.

Deiser, Norman A. 1st Lieut., Engr. R. C.

De Leuw, Charles E. 1st Lieut., Engr. R. C., 4th Engrs.

De Moss, Samuel. Private, School of Meteorology, Sig. C.

Dennis, William F. Maj., Engr. R. C. (*Unassigned*).

Dent, Elliott J. Col., N. A., 26th Engrs.

Derby, George McC. Lt.-Col., Corps of Engrs., U. S. A.

Diesem, Harry C. Capt., Engr. R. C.; Commanding Officer, 404th Engr. Depot Detachment.

Diffenderfer, Claude O. Capt., Engr. R. C., 534th Engrs.

Dillman, George L. Maj., Engr. R. C.

Dobson, Gilbert C. Capt., Engr. R. C., 314th Engrs.

Dodd, Joseph H. L. 2d Lieut., B. W. I. Regt.; Burlington, St. Margaret's Bay, Jamaica.

Doebler, Valentine S. Capt., Q. M. R. C.

Doeleman, H. F. Maj., Q. M. C., N. A.

Dohm, Edward Clarence. Capt., Engr. R. C.

Doten, Leonard S. Capt., Q. M. R. C.

Douglass, Louis R. Capt., Q. M. R. C.

Dow, Hezekiah Shailer. 2d Lieut., 492d Constr. Squadron, Air Service, A. E. F., France.

Doyle, John S. Capt., Engr. R. C.

Drayton, Newbold. Corporal, Battery D, 108th F. A., 53d Art. Brigade, 28th Div.

Drew, C. D. Capt., 11th Engrs. (Ry.), A. E. F., France.

Drummond, William W. Capt., Engr. R. C.

Drury, William F. Capt., Engr. R. C.

Du Bois, George B. 1st Lieut., Engr. R. C.; Commander of 6th Div., Engr. Train, U. S. A., A. E. F., France.

Dunlap, Walter H. 1st Lieut., Engr. R. C., 109th Engrs.

Dunn, Beverly C. Maj., Corps of Engrs., U. S. A.

Dunshee, Bertram K. 1st Lieut., Engr. R. C., 316th Engrs.

Du Pré, Wallace Duncan. Lieut., Q. M. R. C., Mech. Repair Shop Unit No. 303.

Durham, Henry Welles. Maj., Engr. R. C., 41st Engrs., A. E. F., France.

Durham, Leicester. Capt., Engr. R. C., A. P. O. 733, A. E. F., France.

Dykeman, Conrad F. 1st Lieut., Engr. R. C., 116th Engrs., P. O. 733, A. E. F., France.

Eager, V. M. Capt., Q. M. C., N. A.

Eason, F. G. Capt., Engr. R. C., 317th Engrs.

Easton, Russell B. Capt., Engr. R. C., A. E. F., France.

Eckel, Edwin C. Capt., Engr. R. C., Headquarters, A. E. F., France.

Eddy, Albert C. Capt., 55th Engrs., A. E. F., France.

Eddy, Harold M. Asst. Civ. Engr., U. S. N. R. F. (rank of Lieut. (Junior Grade)).

Edgerton, G. E. Lt.-Col., Corps of Engrs., U. S. A.

Edmondson, Ralph S. 1st Lieut., 27th Engrs.

Edwards, G. G. Capt., Co. F, 315th Engrs.

Elliott, J. W. Capt., Engr. R. C., Co. A, 602d Engrs.

Elliott, Malcolm. Lt.-Col., Engrs., N. A., 309th Engrs.

Elliott, Percival. Private, Co. D, 33d Engrs.

Ellison, Alexander H. 1st Lieut., 20th Engrs. (Forestry).

Embury, Aymar, 2d. Capt., Engr. R. C., Camouflage Section, A. E. F., France.

Emerson, Raffe. Ensign, Flying Corps, U. S. N. R. F.

Endicott, Mordecai T. Civ. Engr., U. S. N. (rank of Rear-Admiral).

Enger, Arthur L. Capt., Engr. R. C.

Ernst, Oswald H. Maj.-Gen., U. S. A. (*Retired*).

Estes, F. E. Capt., 17th Engrs. (Ry.), A. E. F., France.

Everett, Ralph B. Private, Co. F, 23d Engrs., A. E. F., France.

Everham, Arthur C. Maj., Q. M. C., N. A.

Fahy, Joseph Augustine. Capt., Engrs., N. A., Co. D, 518th Engrs.

Fairchild, John F. Maj., Q. M. C., Brigade Headquarters, 1st Corps Troops.

Fairlie, John Walter. 1st Canadian Exp. Force (*Retired*).

Fairman, James Robert. Capt., Engr. R. C.

Falk, Myron S. Maj., Ord. R. C.

Farrin, James M. Capt., Engr. R. C.; Adjt., 6th Bn., 20th Engrs., A. E. F., France.

Fassett, Earle W. 1st Lieut., Engr. R. C., 316th Engr. Train, N. A.

Feigel, John H. 1st Lieut., Engr. R. C., A. E. F., France.

Feiner, Mark A. Meteorological Section, A. S., Sig. C.

Feltham, Percy M. Capt., Engr. R. C.

Ferguson, Harry Foster. 1st Lieut., Engr. R. C., A. E. F., France.

Fernald, Gordon H. Capt., Engrs., N. A., Co. D, 304th Engrs.

Fickes, Clark R. Maj., Engr. R. C., A. E. F., France.

Fiebeger, G. J. Col., U. S. A., Headquarters, A. E. F.

Fifer, Frank P. Capt., Engr. R. C., A. E. F., France.

Finley, C. MacF. Capt., Engr. R. C., 503d Service Bn., A. E. F., France.

Finnell, Woolsey. Maj., Engr. R. C., 501st Engrs., U. S. A. P. O. 741, A. E. F., France.

Fischer, Charles, Jr. 2d Lieut., 308th Inf.

Fisher, George Joseph. 2d Co., 4th E. R. O. T. C., Camp Lee, Va.

Fisher, Janon. Maj., Engr. R. C., 522d Engrs.

Fisk, Clinton H. Maj., Q. M. C., N. A.

FitzGerald, C. C. Maj., Engr. R. C., 32d Engrs.

Fitzgerald, Gerald C. 1st Lieut., Engr. R. C., 319th Engrs.

Fitzpatrick, F. J. Capt., Engr. R. C., Co. C, Service Bn., 508th Engrs., A. E. F., France.

Flagg, Herbert J. Capt., C. A. C., N. G. U. S.

Flagler, C. A. F. Brig.-Gen., U. S. A., 5th F. A. Brigade, A. E. F., France.

Fleming, Burton P. Capt., Engr. R. C.

Flick, John K. Capt., Engr. R. C.

Flook, Lyman R. 1st Lieut., Ord. R. C.

Fogerty, Merton S. 34th Prov. Squadron, Aviation Camp, Waco, Tex.

Fogg, Alden K. Asst. Civ. Engr., U. S. N. (rank of Lieut. (Junior Grade)).

Follin, James W. 1st Lieut., San. C., U. S. A.

Fölling, B. N. Capt., Engrs., N. A.

Foote, Olney N. Lieut., Co. G, 322d Inf.

Ford, William Ellis. Capt., Engr. R. C.

Fortney, C. Page. Capt., Engr. R. C.

Forster, Arthur Oscar. Capt., Q. M. C., N. A.

Foster, Ernest H. Ensign, U. S. N. R. F.

Foster, Samuel D. 1st Lieut. and A. D. C., Headquarters, 53d Artillery Brigade.

Fouilhoux, J. Andre. Capt., F. A.

Fountain, Thomas L. Capt., Engr. R. C., Care, C. O., 17th Engrs. (Ry.), U. S. A. P. O. 701, A. E. F., France.

Fowler, Charles Worthington. 1st Lieut., Sig. R. C., A. S., Commanding 485th Aero Constr. Squadron, A. E. F., France.

Fox, Henry. Capt., Engr. R. C., 314th Engrs.

Fox, Stephenson W. Maj., Engr. R. C.

Frank, George Stedman. Lieut., Sig. R. C., A. S., A. E. F., France.

Franks, John B. 1st Sergeant, Co. C, 353d Inf.

Freeman, William B. Capt., Engr. R. C., Co. A, 509th Engrs. (Service Bn.)

French, F. C. Capt., Engr. R. C., 525th Engrs.

Friedman, Harry B. Lieut., Sig. R. C., A. S.

Fries, Amos A. Col., 30th Engrs., N. A.; Chf. of Gas Service, A. E. F., France.

Froiseth, Richard E. 1st Lieut., Engr. R. C.

Frost, Edward M. Asst. Civ. Engr., U. S. N. R. F.

Fry, Alfred Brooks. Capt., U. S. N. N. V.

Fyfe, James Lincoln. Maj., Q. M. C., N. A.

Gailor, Chester F. Maj., Q. M. C., N. A.

Galbreath, Albert W. 1st Lieut., Engr. R. C., Co. B, 12th Engrs. (Ry.), A. E. F., France.

Gallagher, Leonard Bruce. 2d Lieut., Engr. R. C., Ry. Transportation Corps, U. S. A. P. O. 717, A. E. F., France.

Galloway, John D. Maj., Engr. R. C., A. E. F., France.

Galvin, James Augustine. 2d Lieut., Engr. R. C. (*Unassigned*), U. S. Army P. O. No. 714, A. E. F., France.

Garnett, Benjamin J. 1st Lieut., Engr. R. C. (*Unassigned*), A. E. F., France.

Gartensteig, Charles. Capt., Engr. R. C., 535th Engrs.

Gatens, Ray S. 1st Lieut., Engr R. C., Co. C, 42d Engrs., A. E. F., France.

Gausmann, Roy W. Capt., Engr. R. C., Co. D, 303d Engrs.

Gayler, E. R. Civ. Engr., U. S. N. (rank of Commander), Port au Prince, Haiti.

Geib, George Albert. Capt., Engr. R. C., Co. A, 527th Engrs., Service Bn.

Genung, J. H., Jr. Lieut., Engr. R. C.

George, Howard H. Capt., Engr. R. C., Co. E, 305th Engrs.

Getty, Lorenzo T. 1st Lieut., Sig. C., U. S. A., A. S., 75th Aero Constr. Squadron, A. E. F., France.

Gibbs, E. A. Maj., 15th U. S. Engrs. (Ry.), A. E. F., France.

Gibbs, William Wetmore. 1st Lieut., Engr. R. C.

Giesen, Walter E. Private, U. S. M. C., Co. 269, Bn. 7.

Giesting, Frank A. Maj., Engr. R. C., 302d Engrs.

Giffels, William C. 1st Lieut., Engr. R. C.

Gilman, E. Dow. 1st Lieut., N. A., 473d Engrs.

Gladding, James N. Capt., Engr. R. C., A. E. F., France.

Glander, John Henry, Jr. Asst. Civ. Engr., U. S. N. R. F. (rank of Ensign).

Glazier, W. L. Maj., Engr. R. C.

Goddard, Leslie Drew. Capt., Engr. R. C.

Godfrey, Alex. H. Asst. Paymaster, U. S. N. R. F.

Godfrey, Stuart C. Lt.-Col., Engrs., N. A., Headquarters, 318th Engrs., A. E. F., France.

Goethals, George R. Lt.-Col., Corps of Engrs., U. S. A.

Golden, William A. Ensign, U. S. N. R. F., U. S. S. *Mary Alice.*

Goldsmith, Clarence. Maj., Q. M. C., N. A.

Gooch, Carl Joseph. Co. E, 32d Engrs.

Goodman, Benjamin. 1st Class Private, 447th Depot Detachment, Engrs., A. E. F., France.

Goodman, Leon. Capt. and Adjt., 109th Engrs., U. S. N. G.

Gordon, John Blake. Care, Chf. Engr. Officer, General Headquarters, A. E. F., France.

Gordon, Samuel. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Goss, O. P. M. Capt., Sig. R. C., A. S.

Gotwals, John C. Lieut., Corps of Engrs., U. S. A.

Gough, William J. Capt., Engr. R. C.

Gould, William T. Capt., Engr. R. C., U. S. Military P. O. 705, A. E. F., France.

Grady, Frank L. Sergeant, Co. I, 52d Pioneer Inf.

Graff, George W. 40th Co., 10th Tr. Bn., 155th Depot Brigade.

Grant, John R. Capt. and Adjt., Royal Engrs., H. Q., R. E., 24th Div., B. E. F., France.

Grant, Kenneth C. Capt., Sig. R. C., A. S.

Grant, U. S., 3d. Col., U. S. A.

Gravell, William Henry. Capt., Engr. R. C., A. E. F., France.

Graves, E. M. Maj., Engr. R. C., 529th Engrs.

Gray, Earle P. 1st Lieut., Engr. R. C., 16th Engrs. (Ry.), A. E. F., France.

Gray, William B. Maj., Engr. R. C.

Green, Charles N. Maj., Engr. R. C.

Green, Clarence Jasper. 1st Lieut., Oregon Coast Artillery.

Green, F. W. Capt., Engr. R. C., 12th Engrs. (Ry.), U. S. Military P. O. 716, A. E. F., France.

Greene, F. S. Capt., U. S. N. A., Co. B, 302d Engrs.

Greenfield, Robert A. 303d Engrs.

Gregory, Luther E. Civ. Engr., U. S. N. (rank of Captain).

Gregory, William B. Maj., Engr. R. C., A. E. F., France.

Grehan, Bernard H. 1st Lieut., N. A., 312th Engrs.

Griffin, John Alden. Capt., Co. A, 316th Engrs.

Grigsby, Walter B. 1st Lieut., Engr. R. C., 9th Engrs. (Mounted).

Grindrod, Irvin S. 1st Lieut., Engr. R. C. (*Unassigned*).

Griswold, Harry T. 2d Lieut.; Asst. to Artillery Engr., Fort H. G. Wright, N. Y.

Griswold, Hector C. Asst. Civ. Engr., U. S. N. (rank of Lieut. (Junior Grade)).

Griswold, Lee S. Capt., Engr. R. C. (*Unassigned*).

Grodske, Walter J. Capt., Engr. R. C. (*Unassigned*), Manila, Philippine Islands.

Gross, Frederick H. 2d Lieut., Engr. R. C., Co. B, 303d Engrs.

Gross, Henry McC. 1st Lieut., 149th Div., Machine Gun Bn., A. E. F., France.

Grunauer, Mortimer. Headquarters Co., 304th F. A., A. E. F., France.

Gunther, Herman Dietrich. Co. B, 147th Inf.

Guppy, Benjamin Wilder. Maj., Engr. R. C., 14th Engrs. (Ry.), A. E. F., France.

Guptill, Joseph R. Private, Co. E, 23d Engrs., A. E. F., France.

Gutman, David. Maj., Engr. R. C.

Haas, Philip L. Capt., Engr. R. C.

Hains, Peter C. Maj.-Gen., U. S. A.

Halcombe, N. M. Capt., Royal Flying Corps, Egypt.

Haldeman, Walter S. Capt., Engr. R. C.

Hale, Richard King. Lt.-Col., 101st Field Artillery, A. E. F., France.

Hall, Benjamin M., Jr. 1st Lieut., Engr. R. C., Co. B, 26th Engrs., A. P. O. No. 701, A. E. F., France.

Hall, Charles L. Maj., Corps of Engrs., U. S. A., Headquarters, A. E. F., France.

Hall, Gilbert G. 1st Lieut., Engr. R. C., 20th Engrs.

Hall, Julius R. 1st Lieut., Engr. R. C., 515th Service Bn.

Hall, Louis W. Capt., Engr. R. C., Care. Director of Const. and Forestry, S. O. S., P. O. 717, A. E. F., France.

Hall, Oliver Antrum. Capt., Engr. R. C., 23d Engrs., U. S. A. P. O. 708, A. E. F., France.

Hall, Warren E. Capt., Engr. R. C., Co. D, 506th Engrs. (Service Bn.), Base No. 2, A. E. F., France.

Hallberg, Arthur S. 1st Lieut., U. S. N. R. F., U. S. S. *Quinnebaug*.

Hamilton, Edward P. 2d Lieut., F. A. R. C., 306th Field Artillery.

Hammond, John M. Capt., Q. M. C., N. A.

Hanavan, William L. 1st Lieut., 9th Inf.; Adjt., 2d Bn., A. E. F., France.

Hancock, Henry Sydney, Jr. Lieut., Royal Engrs.; Field Engr., First Corps, B. E. F., France.

Hanique, Jules E. Maj., Engrs., N. A., 537th Engrs., A. E. F., France.

Hannan, David E. Capt., Engr. R. C., A. E. F., France.

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Hapgood, Frederic H. Co. A, 26th Engrs., A. E. F., France.

Hardaway, Benjamin H., Jr. Maj., N. A.

Harding, Chester. Col., Corps of Engrs., U. S. A., Balboa Heights, Canal Zone, Panama.

Harding, Ralph L. Capt., Engr. R. C., 35th Engrs.

Harley, Alfred F. Field Clerk, Engr. Corps, A. E. F., France.

Harmon, W. G. Capt., San. C., N. A.

Harrah, O. W. Capt., Engr. R. C., 319th Engrs.

Harris, F. R. Rear-Admiral, U. S. N.

Harris, Frank S. M. Lieut. (Senior Grade), N. N. V.

Harrison, William Burr. Maj., Engr. R. C.

Hart, S. A. 1st Lieut., Engr. R. C., 23d Engrs.

Harter, A. F. Capt., Engr. R. C.

Harts, William W. Brig.-Gen., N. A., G. H. Q., 1er Echelon, B. E. F., France.

Hasbrouck, Oscar. Capt., Engr. R. C., 522d Engrs.

Haskins, C. A. Capt., San. C., N. A.

Haskins, John C. 1st Lieut., Engr. R. C., 22d Engrs.

Hastings, R. P. 1st Lieut., Engr. R. C., Co. D, 26th Engrs.

Haswell, John R. Capt., Engr. R. C. (*Unattached*), A. E. F., France.

Hatch, Frederick N. Capt., Engr. R. C., 35th Engrs., A. E. F., France.

Hauser, Kenneth D. Capt., 18th Engrs. (Ry.), A. E. F., France.

Hawley, John B. Maj., Engr. R. C., 503d Engrs., Service Bn., A. E. F., France.

Hays, Donald S. Capt., Engr. R. C.

Hays, John Coffee. Maj., Q. M. R. C..

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Healey, Charles F. Capt., Engr. R. C., A. P. O. No. 701, A. E. F., France.

Heck, Nicholas H. Lieut., U. S. N. R. F.

Heed, Samuel D. Capt., Ord. R. C.

Hendricks, Ernest D. Capt., Engr. R. C., Co. B, 303d Engrs.

Hendrie, John Gibson. Capt., Engr. R. C.; Adjt., 2d Bn., 318th Engrs. (Sappers).

Henning, Charles S., Jr. Master Engr., Co. A, 21st Engrs., A. E. F., France.

Henry, Earle Underwood. 1st Lieut., Engr. R. C., 116th Engrs., Care, D. G. T., A. P. O. No. 717, A. E. F., France.

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Herzig, Solon. 1st Lieut., Engr. R. C., Co. F, 25th Engrs., A. E. F., France.

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Heuer, W. H. Col., U. S. A. (*Retired*).

Hewett, M. W. 1st Lieut., Engr. R. C., 508th Service Bn.

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Hirzel, Alfred Sparks. Capt., 1st Delaware Inf.

Hjorth, Lawrence R. Co. C, 302d Field Sig. Bn.

Hoad, William C. Maj., Sig. C., N. A.

Hoar, Allen. Civ. Engr., U. S. N. R. F.

Hobbs, Henry W. Maj., Engr. R. C.

Hodge, Henry W. Lt.-Col., R. T. C., N. A.; Mgr. of Roads, G. H. Q., A. E. F., France.

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Holborn, Lewis A. Lieut., 22d Engrs.

Hollyday, R. C. Civ. Engr., U. S. N. (rank of Captain).

Holmes, Thomas H. Capt., Engr. R. C., 311th Engrs.

Holstlaw, Charles Henry. 1st Lieut., Inf. R. C., 124th Inf.

Holt, Andrew H. Capt., Engr. R. C.

Honeyman, Bruce R. Capt., Engr. R. C., Co. A, 313th Engrs., N. A.

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Howard, Gerald B. 1st Lieut., Engr. R. C., Co. E, 17th Engrs. (Ry.), A. E. F., France.

Howe, Wilson Tyler. Capt., Q. M. C., N. A.

Howell, Clarence S. Capt., Engr. R. C.

Howell, George P. Col., Corps of Engrs., U. S. A.

Hoxie, Richard L. Brig.-Gen., U. S. A. (*Retired*).

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Huber, William T. Capt., Engr. R. C.

Hudson, H. W. Maj., Staff of Director-Gen. of Transportation, Care, Director-Gen. of Transportation, A. E. F., France.

Hughes, George L. 2d Lieut., Engrs., N. A.

Huie, Irving V. A. Capt., Co. B, 1st Engrs., U. S. A., A. E. F., France.

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Humann, Edwin August. Private, Co. D, 4th Engrs., U. S. A.

Humphrey, Gilbert Edwin. Maj., Corps of Engrs.

Humphreys, Charles Raymond. Capt., 105th Engrs., 30th Div.

Humphreys, Ewing S. 1st Lieut., Engr. R. C.

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Hunt, Conway B. Maj., Engr. R. C.

Hunt, Leigh A. Maj., 110th Engrs., A. E. F., France.

Hurlbut, H. B. Capt., Ord. R. C.

Hurley, John Patrick. Capt., Co. K, 165th Inf., A. E. F., France.

Husson, William M. Capt., 82d U. S. Field Artillery.

Husted, Alva Guy. Capt., San. C., N. A.

Huston, Tillinghast L'Hommedieu. Maj., Engr. R. C., 1st Bn., 16th Engrs. (Ry.), A. E. F., France.

Hyde, Charles G. Capt., San. C., N. A., Bn. 7, Co. 28.

Hyde, Richard Lewis. 2d Lieut., Engr. R. C., 10th Engrs., A. E. F., France.

Hynds, Harold D. 1st Lieut., Sig. R. C., A. S.

Ingalls, O. L. Maj., Engr. R. C.

Irish, Leland W. Master Engr., 42d Bn., 20th Engrs.

Jackson, Dugald C. Maj., Engr. R. C., A. E. F., France.

Jackson, Jesse A. Maj., 116th Bn., 41st Div., Sig. C.

Jackson, W. B. Maj., Q. M. C., N. A.

Jacobosky, Gilbert G. Capt., Co. B, 55th Engrs., A. E. F., France.

Jacobs, Joseph. Maj., Engr. R. C., 509th Engrs. (Service Bn.), A. E. F., France.

Jacobson, Alfred Leon. Capt., Commandant, 26^{me} Batterie, 246^{me} Reg. d'Artillerie de Campagne, Secteur Postal 30, Armée Française en Campagne, France.

Jacques, Henry L. Capt., Engr. R. C.

Jaenicke, William H. 2d Lieut., Engrs., N. A.

James, Alfred R. 1st Lieut., Q. M. C., N. A.

James, Robert Lane. 2d Lieut., 17th Engrs. (Ry.), A. E. F., France.

Jaques, J. D. Civ. Engr., U. S. N. R. F. (rank of Lieut).

Jasper, T. McLean. Capt., Imperial Forces; Director of Signalling, No. 2, R. G. A., Cadet School, Maresfield Park, Sussex, England.

Jenkins, Charles M. 1st Lieut.; Supply Officer, Headquarters, 3d Bn., 20th Engrs., A. P. O. No. 721, A. E. F., France.

Jenkins, Jenks B. Maj., Engr. R. C.

Jennings, Percy J. Capt.; Adjt., 5th Pioneers Canadians (late 4th Pioneers), Care, Canadian Bank of Commerce, 2 Lombard St., London, E. C., England.

Jerrard, Leigh P. 2d Lieut., Engr. R. C., Headquarters, 67th Artillery Brigade, A. E. F., France.

Jervey, Henry. Brig.-Gen., Corps of Engrs., U. S. A.

Jessup, Walter E. 1st Lieut., Engr. R. C., Co. C, 39th Engrs.

Jewell, Albert Hartwell. 1st Lieut., Sig. C., A. S.

Johnson, Frank Melvin S. Capt., Corps of Engrs., U. S. A., 4th Div., 4th Engrs., A. E. F., France.

Johnson, George A. Maj., Q. M. C., N. A.

Johnson, Hollister. 2d Lieut., Engr. R. C., Co. C, 1st Bn., 20th Engrs., A. E. F., France.

Johnson, J. M. Lt.-Col., 117th Engrs., A. E. F., France.

Johnson, Louis R. Capt., Engr. R. C.

Jonah, F. G. Maj., Engr. R. C.; Chf. Engr., Dept., Light Rys., U. S. Army P. O. 706, A. E. F., France.

Jones, Harry E. Private, A. S., Sig. C., Meteorological Sec.

Jones, Henry L. Maj., Engr. R. C. (*Unassigned*).

Jones, John H. Capt., 1st Canadian Pioneers, B. E. F., France.

Jones, Jonathan. Capt., Engr. R. C., 23d Engrs.

Jones, Lewis Allen. Capt., Engr. R. C.

Jones, Paul Sidney. Co. 2, E. O. T. C., Camp Humphreys, Va.

Jones, Percival C. Corporal, Co. G, 23d U. S. Engrs., A. P. O. 716, A. E. F., France.

Jones, Sidney G. Capt., Engr. R. C., Headquarters Co., 35th Engrs., A. P. O. 735, A. E. F., France.

Jordan, Harry E. Capt., Q. M. C.

Joseph, Jacob. Private, Meteorological Section, Sig. C., U. S. A.

Jouine, G. P. F. Sous Lieut. au 81eme Regt. d'Artillerie, A. S. 14, par B. C. M., France.

Judson, William V. Lt.-Col., Corps of Engrs., U. S. A.

Kane, Daniel C. 1st Lieut., Engrs., N. A., 466th Pontoon Train.

Kane, Irving P. Capt., Engr. R. C., Headquarters, 45th Engrs.

Karnopp, Edwin B. Capt., Engr. R. C., 2d Bn., 22d Engrs.

Kastenhuber, E. G., Jr. Capt., San. C., N. A.

Kaufmann, Ernst G. Private, 499th Aero Squadron.

Keenan, John T. Maj., Engr. R. C., 28th Engrs.

Keith, Gerald Marcy. Lieut., Engr. R. C., Co. B, 116th Engrs., A. E. F., France.

Keller, Charles. Col., Corps of Engrs., U. S. A.

Kelly, Earl W. Capt., Engr. R. C.

Kelly, Hugh Ambrose. Sergeant, Co. S, 312th Inf.

Kelly, William. Col., Corps of Engrs., U. S. A., 117th Engrs., A. E. F., France.

Kemp, John E. Capt., Engr. R. C.; Chf. Engr., Ordnance Dept. in France, Care, J. H. Hood, 4 rue d'Auber, Paris, France.

Keys, Edward A. Capt., Engr. R. C., A. E. F., France.

Khachadoorian, H. H. 1st Lieut., Engr. R. C., Co. C, 55th Engrs.

King, Clifford M. Capt., Engr. R. C.

King, Eric T. Maj., Q. M. C., N. A.

King, Howard L. 2d Lieut., Engr. R. C., Co. B, 27th Engrs.

King, Thomas R. 1st Lieut., Engr. R. C., A. E. F., France.

King, W. S. Capt., Q. M. R. C.

Kingsley, E. A. Maj., Engr. R. C., A. E. F., France.

Kingsley, George. Capt., Engr. R. C.

Kinne, G. W. Capt., Engr. R. C.

Kinnear, Lawrence W. 2d Lieut., Sig. R. C., A. S.

Kipp, Frederick M., Jr. 33d Engrs., U. S. A.

Kirby, Luther H. Capt., Engr. R. C.

Kissack, A. B. Capt., Engr. R. C., 515th Bn.

Kitchen, Ernest. 1st Lieut., Engr. R. C.

Kittredge, Frank A. Capt., 43d Engrs., A. E. F., France.

Kitts, Joseph A. Capt., Engr. R. C., A. P. O. 726, A. E. F., France.

Klink, J. H. Maj., Q. M. C., N. A.

Kluegel, Harry A. Capt., Q. M. R. C.

Knight, G. W. Capt., Engr. R. C., 46th Engrs., A. E. F., France.

Kniskern, Philip Wheeler. Capt., Engr. R. C.

Knollman, Enno P. Ensign, U. S. N. R. F.

Knost, W. A. 1st Lieut., C. A. R. C.

Koop, Louis D. Capt., Q. M. C., N. A.

Krach, Fred R. Private, Co. A, 23d Engrs.

Kreamer, A. W. 1st Lieut., Engr. R. C. (*Unassigned*).

Krigbaum, Lowell G. 1st Lieut., Engr. R. C., Care, Director of C. and F., A. E. F., France.

Kutz, Charles W. Brig.-Gen., N. A.

La Bach, Paul M. Maj., Engr. R. C., A. E. F., France.

Labsap, Alfred H. 1st Lieut., Engr. R. C., 114th Engrs.

La Forge, Frederick W. Maj., Engr. R. C.

Lake, Edward N. Maj., Q. M. C., N. A.

Lamb, Lyman C. Capt., Engr. R. C.

Lambert, Byron J. Maj., Engr. R. C., 23d Engrs. (Highway).

Lamphere, Frank E. Col., Q. M. C., N. A.

Lamson, William M. Maj., Engr. R. C., 306th Engrs.

Lancashire, Forest H. Capt., Engr. R. C.

Land, John T. Capt., Engr. R. C.

Lansdale, John. Capt., Engr. R. C., Military Post Office No. 701, A. E. F., France.

La Roche, Arthur L. 1st Lieut., Engr. R. C., A. E. F., France.

Larrison, George K. Capt., Engr. R. C., Headquarters, Hawaiian Dept., U. S. A., Honolulu, Hawaii.

Lathbury, Benjamin Brentnall. Maj., Ord. R. C.

Latimer, C. A. 2d Lieut., Engr. R. C., Co. E, 3d Engrs., Corozal, Canal Zone, Panama.

Laughlin, Harmon L. Capt., Engr. R. C.; Topographical Officer, 108th Engrs.

Laverty, Samuel Perry. Regt. Sup. Sergeant, 316th Am. Tr.

Lawrence, Frank Elmaker. Capt., 17th Engrs. (Ry.), A. E. F., France.

Lawton, Richard M. Maj., Engr. R. C., A. E. F., France.

Learned, A. P. 1st Lieut., San. C., N. A., Co. 28, Bn. 7.

LeBaron, R. W. P. 1st Lieut., Co. C, 13th Engrs. (Ry.), A. E. F., France.

Leckie, Alexander R. Capt., 111th Engrs., U. S. A.

Lee, Alonzo Church. 1st Lieut., Inf. R. C., 17th Machine Gun Bn.

Lee, Augustine L. Capt., Engr. R. C. (*Unassigned*).

Lee, Charles A. Lieut. (Senior Grade), U. S. N. R. F.

Lee, Charles H. 1st Lieut., Engr. R. C., A. E. F., France.

Lee, John Louis. Maj., Q. M. C., N. A.

Leeds, Charles T. Capt., U. S. A.

Lehrbach, Henry G. Asst. Civ. Engr., U. S. N. (rank of Lieut. (Junior Grade)).

Leisen, Theodore A. Maj., Q. M. R. C.

Leland, O. M. Lt.-Col., Engr. R. C., 303d Engrs., A. E. F., France.

Lemen, William C. S. Capt., Engr. R. C.

Leonard, O. Y. 1st Lieut., Ord. R. C.

Letton, Harry P. Capt., Engr. R. C., A. E. F., France.

Lewis, Charles Granville. Private, Co. A, 21st Engrs., A. E. F., France.

Lewis, F. H. Maj., Engr. R. C.

Lewis, Harold McLean. 2d Lieut., Co. A, 502d Engrs., A. E. F., France.

Lewis, Luther H. Maj., Q. M. C., N. A.

Libbey, V. B. Lieut., Engr. R. C., A. E. F., France.

Lightner, George W. C. Capt. and Supply Officer, 21st Engrs. (Light Ry.), A. E. F., France.

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Lipari, A. F. Private, A. S., Sig. C.

Lisman, Oliver C. 1st Lieut., 519th Engrs.

Livermore, Norman B. Capt., Engr. R. C., A. E. F., France.

Livingston, Archibald R. Maj., Engr. R. C., 115th Engrs.

Lockhardt, William Francis. 2d Lieut., Q. M. C., N. A.

Lockwood, Richard J. 2d Lieut., F. A., U. S. N. A.

Logan, Chester R. Capt., Co. C, 502d Engrs., A. E. F., France.

Logan, Vernon L. 2d Lieut., N. A., 530th Engrs.

Longley, Francis F. Lt.-Col., 26th Engrs., A. E. F., France.

Lord, Arthur R. Capt., Engr. R. C.

Louckes, Frank I. Capt., Engr. R. C., Inland Water Transportation Service, A. P. O. 702, A. E. F., France.

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Lyon, Léon E. Capt., Engr. R. C., Office of Chf. Engr., Headquarters, A. E. F., France.

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MacDiarmid, Milo S. Maj., Engr. R. C.

MacGlashan, Alexander. Maj., 104th Engrs., U. S. A.

Macintosh, P. H. M. Capt., Tropical Force, Rabaul, New Guinea.

Mackenzie, Leon R. Capt., Q. M. C.

MacNaughton, Percival J. Asst. Civ. Engr., U. S. N. R. F.

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McCandliss, Edgar S. Capt., Engr. R. C., 314th Engrs., N. A.

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McClellan, George A. Lieut., Sig. C.

McClintock, Hallett Edward. Capt., Engr. R. C., Care, D., C., and F., A. P. O. 717, A. E. F., France.

McClure, Hunter. 1st Lieut., Engr. R. C.

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McDonald, Harry L. Capt., Engr. R. C.

McDonnell, Francis R. Lieut. (Junior Grade), U. S. N. R. F.

McDonough, Michael J. Col., 114th Engrs.

McFarland, H. F., Jr. 1st Lieut., Co. F, 12th Engrs. (Ry.), A. E. F., France.

McGee, Arthur B. Sergeant, Ord. Dept., N. A.

McGee, Harold G. 1st Lieut., San. C., N. A.

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McGeehan, Paul. Capt., Co. D, 12th Engrs. (Ry.), A. E. F., France.

McGlathery, Sam L. Capt., Engr. R. C., 312th Engrs.

McGregor, Robert Roy. Capt., 21st Engrs.

McGrew, John A. Maj., Q. M. R. C.

McIntosh, Samuel F. Capt., Ord. R. C.

McKay, George A. Civ. Engr., U. S. N. (rank of Commander).

McKenney, Charles A. Maj., Engr. R. C.

McKinstry, Charles Hedges. Brig.-Gen., N. A., 67th F. A. Brigade, A. E. F., France.

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McLoud, Paul. 1st Lieut., Engr. R. C., Co. F, 11th Engrs., A. E. F., France.

McMeekin, Charles William. Maj., Engr. R. C.

McMillan, W. Bruce. 1st Lieut., Engr. R. C., A. E. F., France.

McMullen, Clements. Lieut., Sig. R. C., A. S.

McNayr, George E. 2d Lieut., Engr. R. C., 33d Engrs.

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Mail, Eugene Frederick. 1st Lieut., Engr. R. C., 4th Engrs.

Malloy, John Michael. Lieut., 342d F. A.

Malsbury, Omer Evert. Capt., Engr. R. C., 3d Engrs., Corozal, Canal Zone, Panama.

Maltby, Frank B. Maj., Engr. R. C.

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Mangold, John Frederic. Capt., Engr. R. C. (*Unassigned*).

Manning, William J. H. 2d Lieut., Engr. R. C., 52d Engrs., A. E. F., France.

Mansfield, Newton. Lt.-Commander, U. S. N. (*Retired*).

March, George Miles. 1st Lieut., 507th Engrs.

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Marshall, Robert B. Maj., Engr. R. C.

Marston, Anson. Maj., Engr. R. C., 109th Engrs.

Marx, Raymond. 2d Lieut., Co. K, 308th Inf., A. E. F., France.

Maslen, Harold C. Ensign, U. S. N. R. F.

Massei, Cæsar. Maj., N. A., 22d Engrs.

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Noyes, Stephen Henley. 1st Lieut., Sig. R. C., A. S., 1st Aero Squadron, A. E. F., France.

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Pagon, William Watters. Capt., Q. M. C., N. A.

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Patterson, Laurence. Sergeant, Co. A, 102d Engrs.

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Pease, H. T. Capt., 316th Trench Mortar Battery.

Peck, John S. Private, U. S. A. S. M. A., Photo. Div.

Peck, Myron Hall. Capt., Engr. R. C.

Pennell, J. Roy. Capt., Engr. R. C., Co. A, 117th Engrs., A. E. F., France.

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Perry, Charles E. Capt., Engr. R. C.

Perry, F. W. Capt., Engr. R. C., A. E. F., France.

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Phillips, Walter B. Capt., Q. M. C., N. A.

Phipps, T. E. Capt., Engr. R. C.

Pickett, Frank Hurd. 1st Lieut., Engr. R. C., 1st Replacement Engrs.

Pierce, Charles W. Civ. Engr., U. S. N., U. S. S. *Nebraska.*

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Pillsbury, G. B. Col., 115th Engrs.

Pirnie, H. Malcolm. Lieut.; Asst. Engr., Headquarters, Director-General of Transportation, A. E. F., France.

Plank, David Harlan. 1st Lieut., Engr. R. C., Co. B, 310th Engrs.

Poole, J. H. Maj., 16th Engrs., A. E. F., France.

Poorman, A. P. Capt., Co. A, 29th Engrs.

Post, A. J. Sergeant, Q. M. C.

Post, William S. Maj., Engr. R. C., 316th Engrs.

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Pratt, Arthur H. Capt., Co. B, 26th Engrs., A. E. F., France.

Preston, Harry L. Capt., Engr. R. C., 22d Engrs.

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Proctor, R. F. Maj., Q. M. R. C.

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Reding, James H. Capt., U. S. N. G., Co. A, 112th Engrs.

Reed, Howard S. Capt., Engr. R. C.

Reed, Paul Lyon. Civ. Engr., U. S. N. (rank of Commander).

Reeder, Harry C. 1st Lieut., Engr. R. C.

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Sewell, John Stephen. Col., Engrs., N. A., Military P. O. No. 701, A. E. F., France.

Sexton, George F. Sergeant, 1st Class.

Seymour, Horatio. 1st Lieut., Ord. R. C.

Shafer, Ernest Alton. 1st Lieut., Engr. R. C.

Shafer, J. C. F. Capt., C. A. R. C., A. E. F., France.

Shankland, Ralph Graham. 1st Lieut., Engr. R. C.

Shaw, Arthur Lassell. Capt., Engr. R. C., 301st Engrs.

Shaw, Arthur M. Maj., Engr. R. C., Mech. Repair Unit No. 305.

Shaw, Franklin Dickinson. Capt., Engr. R. C.

Shearer, D. McD. Capt., Engr. R. C., 604th Engrs.

Sheley, Horace W. Capt., Engr. R. C.

Shepard, George Milson. Capt., Co. D, 3d U. S. Engrs., Schofield Barracks, Honolulu, Hawaii.

Sheppard, Norman K. Master Engr., Junior Grade, Headquarters Co., 313th Engrs.

Sheridan, L. V. Sergeant, F. A., Saumur Artillery School, U. S. A. P. O. 718, A. E. F., France.

Sibert, William L. Maj.-Gen., U. S. A.

Silsbee, J. A. 1st Lieut., Ord. R. C.

Silvernail, Alfred Kimberly. 1st Lieut., Q. M. C., N. A.

Skelly, J. W. Capt.; Supply Officer, 12th Engrs. (Ry.), A. E. F., France.

Sleight, Reuben Benjamin. Lieut., Sig. C., U. S. A.

Sleppy, K. B. Capt., 4th U. S. Engrs.

Slifer, Hiram J. Lt.-Col., 21st Engrs. (Light Ry.), A. E. F., France.

Sloan, William Glenn. 1st Lieut., Engr. R. C. (*Unassigned*).

Sloan, William Griffith. Maj., Engr. R. C.

Small, James H., Jr. Maj., Q. M. C., N. A.

Smallman, R. A. Capt., Co. F, 25th Engrs., A. E. F., France.

Smead, R. C. Maj., Engr. R. C. (*Unassigned*).

Smillie, Ralph. Ensign, U. S. N., U. S. S. *Massachusetts*.

Smith, Albert. Maj., 2d Bn., 309th Engrs.

Smith, Alexander Crawford, Jr. 1st Lieut., Engr. R. C., Truck Co. No. 10, 23d Engrs., A. E. F., France.

Smith, Charles E. Maj., Q. M. C., N. A.

Smith, Chester Alexander. Capt., San. C., N. A.

Smith, Chester K. Capt., Engrs., N. A., Care, Director of Constr. and Forestry, Headquarters, S. O. S., A. E. F., France.

Smith, Claire Howland Wallace. 1st Lieut., Engr. R. C. (*Unassigned*), A. E. F., France.

Smith, Clarence Urling. Capt., Co. E, 107th Engrs., A. E. F., France.

Smith, Clarke Stull. Col., Corps of Engrs., U. S. A., Headquarters, 311th Engrs.

Smith, Earl Audie. 1st Lieut., Engr. R. C.

Smith, Edward King. 2d Lieut., Sig. R. C.

Smith, Francis M. Capt., Engr. R. C., Headquarters, 59th Engrs. (Ry.), U. S. A. P. O. 708, A. E. F., France.

Smith, Layton Fontaine. Lieut., U. S. N. R. F.

Smith, Maxwell W. Capt., Engr. R. C., Co. F, 308th Engrs., A. E. F., France.

Smith, Merritt H. Col., 1st N. Y. Field Artillery, N. G. U. S.

Smith, Richard B. Meteorological Section, A. S., Sig. C.

Smith, Robert C. Maj., Q. M. C., N. A.

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Smith, W. W. Master Engr., 16th Engrs. (Ry.), A. E. F., France.

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Snell, Edward Beniah. 1st Lieut., Engr. R. C.

Snodgrass, W. T. Sergeant, Co. C, 28th Engrs., A. E. F., France.

Snook, Thomas E., Jr. 1st Lieut., Engr. R. C., Co. B, 306th Engrs.

Snyder, Frederic Antes. Col., 103d Engrs.

Snyder, George Duncan. Capt., 102d Engrs.

Snyder, Hubert Earl. Capt., Engr. R. C.

Soest, Hugo C. 1st Lieut., Engr. R. C., Co. A, 25th Engrs., A. E. F., France.

Solomon, G. R. Maj., Engr. R. C.

Sourwine, J. A. Capt., Engr. R. C.

Spear, Philip H. Capt., Engr. R. C.

Spear, Walter E. Maj., Q. M. R. C.

Spencer, Charles B. Lieut., Care, Chf. Ord. Officer, P. O. 717, A. E. F., France.

Spencer, Herbert. Capt., Engr. R. C., Co. H, 23d Engrs., A. E. F., France.

Sperry, L. N. 1st Lieut., Engr. R. C., 6th U. S. Engrs., A. E. F., France.

Sprague, H. M. 1st Lieut., Engr. R. C., Care, G. P. A., Labor Bureau, A. P. O. 702, A. E. F., France.

Stafford, Fred D. Capt., Engr. R. C., 105th Engrs.

Stallings, John R. Sergeant, Headquarters Co., 3d Anti-Aircraft Bn.

Stanford, Homer R. Civ. Engr., U. S. N. (rank of Commander).

Stanley, W. E. 1st Lieut., Engr. R. C., Co. B, 101st Engrs., A. E. F., France.

Stanton, Charles B. Capt., Engr. R. C., Co. E, 15th Engrs. (Ry.). A. E. F., France.

Stanton, W. L. 2d Lieut., N. A., 304th Engrs.

Starr, F. Charles. Capt., Q. M. C., N. A.

Starrett, William A. Col., Q. M. C., N. A.

Stayton, Edward M. Maj., 110th Engrs.

Stearns, Fred LeRoy. Lieut., Co. A, 107th Inf., U. S. A.

Stearns, Ralph H. Lieut. (Junior Grade), U. S. N. R. F.

Steep, James B. Capt., Engr. R. C.

Steese, James Gordon. Lt.-Col., Corps of Engrs., U. S. A.

Steeves, C. McN. Lieut., 9th Field Co., Canadian Engrs., B. E. F., France.

Steinberg, Max. 1st Lieut., U. S. R., U. S. Coast and Geodetic Survey.

Stellhorn, Adolf. Capt., Engr. R. C., Office, Chf. Engr., S. O. R., P. O. 717, A. E. F., France.

Stem, Clifford H. 2d Lieut., Engr. R. C., 101st Engrs., L. of C., A. E. F., France.

Stephens, Uel. Lieut., 57th U. S. Inf.

Stern, Eugene W. Maj., Engr. R. C.; Supt. of Roads, Care, C. G. Base Section No. 2, U. S. Military P. O. 705, A. E. F., France.

Stewart, John. Maj., Engr. R. C.

Stewart, John T. Maj., Engr. R. C.

Stickle, H. W. Lt.-Col., U. S. A. (*Retired*).

Stillwell, Howard L. 2d Lieut., Q. M. C., N. A.

Stineman, Norman M. Capt., Engr. R. C., 33d Engrs.

Stivers, A. D. Capt., Inf. R. C.

Storey, Franklin S. 1st Lieut., Engr. R. C., A. E. F., France.

Stowe, H. D. Capt., Engr. R. C.

Strachan, Joseph J. Asst. Civ. Engr., U. S. N. (rank of Lieut. (Junior Grade)).

Strachan, Norman F. Private, 23d Engrs.

Strecker, R. A. Capt., Engr. R. C., Co. A, 309th Engrs.

Street, J. Z. Private, Specialist Detachment, Co. A, 26th Engrs., A. E. F., France.

Strehan, George E. 2d Lieut., Battery E, 351st F. A.

Strickler, G. B. Maj., Engr. R. C.

Strickler, T. J. Capt., Engr. R. C.

Stronach, Robert S. Lieut., 10th Field Co., Canadian Engrs., B. E. F.. France.

Stupp, John G. 1st Lieut., Ord. R. C.

Sturtevant, C. W. Lt.-Col., 15th U. S. Engrs., A. E. F., France.

Summers, R. E. J. 1st Lieut., Engr. R. C., Co. F, 16th U. S. Engrs. (Ry.), A. E. F., France.

Suter, Russell. Capt., Engr. R. C., Care, S. E. O., Int. Sect., S. O. S., A. E. F., France.

Sutton, Frank. Maj., Engr. R. C., 29th Engrs.

Swaren, J. W. Capt., Engr. R. C., Headquarters, 318th Engrs. (Sappers), A. E. F., France.

Swartz, Leon. Master Engr., 15th U. S. Engrs., A. E. F., France.

Sweeney, Harry C. Capt., Q. M. R. C.

Sweetser, C. H. Capt., Engr. R. C., Co. A, 43d Engrs., A. E. F., France.

Sweetser, E. O. Capt., Engr. R. C. (*Unattached*), A. E. F., France.

Swett, Everett H. Capt., Engr. R. C.

Sykes, George. Capt., Engr. R. C., A. E. F., France.

Symonds, G. R. B. Capt., Engr. R. C., Co. A, 605th Engrs.

Tainter, F. S. Maj., Engr. R. C.

Tate, R. L. 1st Lieut., Engr. R. C., 303d Engrs.

Tay, S. W. Lieut., U. S. N. N. V., U. S. S. *Wenonah.*

Taylor, Arthur. 1st Lieut., Engr. R. C.

Taylor, Edwin A. Maj., Engr. R. C.

Taylor, Harry. Brig.-Gen. N. A.; Chf. Engr., A. E. F., France.

Taylor, Henry. Capt., Engr. R. C., 304th Engrs.

Taylor, Hugh M. Maj., Care, D. G. T., A. P. O. 717, A. E. F., France.

Taylor, Nelson. Lieut., U. S. N., U. S. S. *Bridgeport.*

Taylor, P. M. 2d Lieut., R. E., 237th Field Co., B. E. F., Italy.

Taylor, Seneca V. Capt., C. A. R. C.

Taylor, William T. Capt., Royal Flying Corps, B. E. F., France.

Taylor, Wyllys H. Capt., Engr. R. C., 306th Engrs., N. A.

Ten Hagen, Henry. 2d Lieut., Engr. R. C., 303d Engrs.

Tenney, Willis R. Capt., Engr. R. C., Eng. Depot, U. S. A. P. O. 712, A. E. F., France.

Thomas, Charles D. Capt., Engr. R. C., Co. B, 507th Engrs., A. E. F., France.

Thomas, W. E. Capt., San. C., N. A.

Thompson, Sanford E. Maj., Progress Section, Office of Chf. of Ordnance, U. S. A.

Thomsen, S. L. Capt., Engr. R. C., Co. A, 57th Engrs.

Thomson, F. M. Capt., 39th Engrs., U. S. A., A. E. F., France.

Throop, George H. Capt., Engr. R. C., Co. E, 24th Engrs.

Thurber, Clinton D. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Thurston, Eugene T. Capt., Engr. R. C.

Tilden, Charles Joseph. Capt., Engr. R. C. (*Unassigned*).

Tinsley, R. B. Capt., Engr. R. C., Co. A, 605th Engrs.

Tirrell, Charles Edwards. Sig. C., A. S. (Non-Flying).

Todd, Frank Herbert. Maj., Q. M. R. C.

Todd, Oliver J. Capt., Engr. R. C.; Adjt., 3d Bn., 20th Engrs., A. E. F., France.

Tolles, F. C. 1st Lieut., Engr. R. C., 112th Engrs.

Tomlinson, Alfred Thomas. Maj., Canadian Engrs.; Insp., Small Arms Ammunition, Dominion Arsenal, Lindsay, Ont., Canada.

Tompkins, Robert Harry. 1st Lieut., 111th Engrs.

Topping, Perry. Capt., Engr. R. C., 5th U. S. Engrs.

Torrance, William M. Capt., Engr. R. C.

Townsend, C. McD. Col., Corps of Engrs., U. S. A., 12th Engrs. (Ry.), A. E. F., France.

Tracy, C. C. Capt., C. A. R. C.

Tracy, Herbert Herman. 1st Lieut., Engr. R. C., Engr. Wagon Co. 4, 23d Engrs., U. S. A. P. O. 708, A. E. F., France.

Travers=Ewell, Andrew. Care, American Consul, Para, Brazil.

Trimpi, Allan Littell. 1st Lieut., 104th Engrs.

Trout, Alexander Linn. Capt., Engr. R. C. (*Unassigned*), A. E. F., France.

True, Albert O. Capt., Engr. R. C.

Trueblood, P. McG. Lieut., U. S. N. R. F.

Tucker, H. F. Ensign, U. S. N. R. F.

Turley, Jay. Capt., Engr. R. C., Care, Eng. Purchasing Officer, P. O. No. 702, A. E. F., France.

Turner, Daniel Norman. 2d Lieut., Engr. R. C., 304th Engrs.

Turner, Nathaniel Parker. Capt., U. S. N. G.; Topographical Officer, 111th Engrs.

Tuska, Gustave R. Maj., Engr. R. C.

Tyson, William C. Capt., Engr. R. C., Co. No. 2, Camp Custer Replacement Draft, A. E. F., France.

Uhler, W. D. Lt.-Col., Q. M. C., N. A.

Van Buren, Maurice Pelham. Capt., Corps of Engrs., 602d Engrs.

Vandemoer, N. C. Capt., Engr. R. C.

Vandervoort, B. F. Capt., Engr. R. C.

Vandevanter, Elliott. Capt., Engr. R. C., Co. D, 503d Engrs., A. E. F., France.

Van Ness, R. A. Lieut., Engr. R. C.

Van Pelt, Sutton. Capt., Engr. R. C., 110th Engrs.

Van Suetendael, Achille O. Capt., Engr. R. C.

Van Zile, Harry Lee. Maj., Engr. R. C., A. E. F., France.

Vaughan, Henry F. Capt., San. C., N. A.

Verrill, George E. Maj., Engr. R. C.

Vincent, W. H. 1st Lieut., Engr. R. C.

Vogleson, J. A. Maj., San. C., N. A.

Volk, Wendell Douglas. 1st Lieut., Engr. R. C., Co. E, 20th Engrs., A. E. F., France.

von Deesten, A. P. Maj., Corps of Engrs., U. S. A.

Wade, George W. 1st Lieut., Co. D, 2d Bn., 117th Engrs. 42d Div., A. E. F., France.

Wadsworth, George R. Maj., Sig. C., U. S. A.

Wadsworth, Henry H. Maj., Engr. R. C. (*Unassigned*).

Wagner, John, Jr. 1st Lieut., Cav. R. C., First Corps School, Army P. O. No. 703, A. E. F., France.

Waite, Clement F. 2d Lieut., Engr. R. C.

Waite, H. M. Lt.-Col., R. T. C., N. A., Care, Railroad Transportation Corps, A. E. F., France.

Waldron, Albert E. Col., 35th Engrs., U. S. A., A. E. F., France.

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Walker, Elton D. Capt., Engr. R. C., Co. A, 5th U. S. Engrs., A. E. F., France.

Walker, Harry Bruce. Capt., Engr. R. C.

Walker, Meriwether Lewis. Col., Engrs., N. A., G. H. Q., A. E. F., France.

Walker, W. Kemp. Capt., Engr. R. C.

Wallace, David A. Capt., Engr. R. C., Headquarters, Director General of Transportation, A. P. O. 717, A. E. F., France.

Wallace, Harold U. Maj., Engrs., N. A.

Waller, Alexander C. 1st Lieut., Engr. R. C., 22d Engrs.

Waller, Percy. Capt., Engr. R. C.

Walton, H. B. Capt., Engr. R. C., 312th Engrs.

Ward, George S. 2d Lieut., Engr. R. C., Co. A, 117th Engrs., A. E. F., France.

Ward, Jasper D. Corporal, Co. C, 55th Inf.

Ward, Lyman Wise. Capt., C. A. R. C.; Adjt., 1st Bn., 63d Artillery, C. A. C.

Ware, Howard T. 2d Lieut., Q. M. C., N. A., Bakery Co. No. 317.

Ware, John. 1st Lieut., Co. A, 101st Engrs., A. E. F., France.

Ware, Norton. Capt., Engr. R. C.

Warfield, Ralph M. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Waring, C. T. Maj., Sig. R. C.

Warner, Elwin S. Capt., Engr. R. C., Co. B, 301st Engrs.

Warnock, W. H. Capt., Q. M. C., N. A.

Warren, Horace P. Maj., 55th Engrs., N. A., A. E. F., France.

Warren, James G. Col., Corps of Engrs., U. S. A.

Warren, Minton M. 1st Lieut., Engr. R. C., Headquarters Co., 101st Engrs., 51st Brigade, 26th Div., A. E. F., France.

Warren, Philip R. Maj., Royal Engrs., P. C. E., A. P. O. S. 10, B. E. F., France.

Watkins, Guy A. Capt., Engr. R. C.

Watson, D. M. Lieut., M. T., A. S. C., 100th Siege Battery, R. G. A., B. E. F., France.

Watson, George L. Capt., Co. B, 30th U. S. Engrs.

Watson, Winslow B. Lieut., Co. C, 7th N. Y. Inf. (114th).

Watt, David A. Maj., Engr. R. C.

Waugh, William H. Maj., Engrs. N. A.

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Weaver, C. J. 1st Lieut., Engr. R. C.

Weaver, Earll Chase. Asst. Civ. Engr., U. S. N. R. F.

Weaver, Frank L. Capt., Engrs. N. A., 305th Engrs.

Webb, Claude A. Lieut., F. A. R. C., A. E. F., France.

Webb, De Witt Clinton. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Webb, George H. Lt.-Col., 16th U. S. Engrs. (Ry.), A. E. F., France.

Webb, I. Gano. Capt., Engr. R. C.

Webb, Walter Loring. Maj., Engr. R. C., A. E. F., France.

Webster, Maurice A. Capt., Ord. Dept., N. A.

Weeks, W. C. Maj., Engrs., N. A., 32d Engrs., Care, Y. M. C. A. Hotel for Officers, Paris, France.

Welles, Theodore L., Jr. 2d Lieut., Engr. R. C.

Welsh, Russell D. Private, Co. F, 115th Engrs, A. E. F., France.

Wenige, Arthur E. Maj., Engr. R. C., 317th Engrs.

Wenzell, Andrew P. Capt., Co. F, 16th U. S. Engrs. (Ry.), A. E. F., France.

West, Edward Hazzard. Capt., Engr. R. C., Co. F, 5th Engrs.

Wheat, G. Neville. Capt., Engr. R. C.

Wheeler, Frank I. 2d Lieut., Sig. R. C., A. S.

Wheelock, De Forest A. Col., U. S. A.

Whiteaker, Robert O. Capt., 132d Field Artillery.

Whitman, Ezra B. Maj., Q. M. R. C.

Whitman, Ralph. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Whitney, John T. 2d Lieut., F. A. R. C., 2d Corps Artillery Park, A. E. F., France.

Whitney, Ralph Edward. 1st Lieut., San C., N. A.

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Wickersham, John H. Maj., Engr. R. C., P. O. 706, A. E. F., France.

Widdicombe, R. A. Maj., Engr. R. C.

Widdicombe, Stacey H. U. S. S. M. A., Princeton, N. J.

Wiggin, Thomas H. Capt., Engr. R. C., Care, Gen. Taylor, A. E. F., France.

Wiggins, Ralph Raymond. 1st Lieut., Sig. R. C., A. S.

Wilcox, Ernest Hardwick. Capt., Engr. R. C.

Wild, H. J. Capt., Engr. R. C., 3d Engrs., Corozal, Canal Zone, Panama.

Wildish, Frederic Newton. Capt., Engr. R. C., Co. B, 309th Engrs.

Wilgus, W. J. Col., Engrs., N. A., A. E. F., France.

Willard, George T. Private, Co. E, 318th Engrs.

Willard, N. R. Capt., Engr. R. C.

Williams, Alan F. 2d Lieut., Co. B, 18th Engrs. (Ry.), U. S. Army P. O. No. 705, A. E. F., France.

Williams, Samuel W. Maj., Engr. R. C.

Wiilliamson, Harry. Capt., Royal Engrs., British Army; O. C. 272d Ry. Constr. Co., R. E., E. E. F., Egypt.

Williamson, Lee H. 2d Lieut., Engr. R. C., Co. A, 55th Engrs.

Williamson, Sydney B. Lt.-Col., Engrs., N. A.

Williar, Harry D., Jr. 1st Lieut., 1st U. S. Engrs., A. E. F., France.

Willis, Walter John. Lieut. (EDO).

Wilson, Edbert C. Capt., Engr. R. C.

Wilson, Everitt W. Capt., Engr. R. C., Co. A, 304th Engrs.

Wilson, Harry P. Capt., Engr. R. C., 310th Engrs.

Wilson, Robert B. M. Capt., Engr. R. C., 311th Engrs.

Wilson, William R. Maj., 23d Field Co., R. E., B. E. F., France.

Wing, Charles B. Maj., Engr. R. C., 23d Engrs., A. P. O. 708, A. E. F., France.

Winn, Walter E. Lt.-Col., Engr. R. C., 114th Engrs.

Winn, Walter S. Maj., Engr. R. C.

Winton, Walter Ferrell. Capt., 14th U. S. Field Artillery.

Wood, B. Russell. Capt., Engr. R. C. (*Unassigned*), U. S. M. P. O. 733, A. E. F., France.

Wood, Frederic J. Maj., Engr. R. C.

Woodard, Wilkie. Capt., Engr. R. C., Co. H, 35th Engrs., A. P. O. 735, A. E. F., France.

Woodle, Bernon Tisdale. Capt., Engr. R. C.

Woodruff, Glenn B. 1st Lieut., Engr. R. C.

Woolworth, W. H. Capt., U. S. A., Headquarters, 2d Brigade, 1st Div., A. E. F., France.

Wooten, William P. Maj., Corps of Engrs., U. S. A.

Wright, John Bertram. Capt., Engr. R. C.

Wrightson, William D. Maj.; Chf. of San. C., U. S. A.

Yeo, Herbert W. Capt., Engr. R. C.

Yereance, Alex. W. 1st Lieut., Co. F, 305th Engrs., A. E. F., France.

Yost, Howard McC. Capt., Engr. R. C.

Young, Frederick C. Capt., Engr. R. C.; Adjt., 114th Engrs.

Young, George S. Capt., Engr. R. C.

Young, Samuel M. Capt., Engr. R. C.

Zinn, George A. Col., Corps of Engrs., U. S. A.

MEMBERSHIP

(From May 3d to August 8th, 1918)

ADDITIONS

MEMBERS		Date of Membership.
Adams, Arthur. Maj., Ord. R. C.; Inspection Mgr., Albemarle Bldg., New York City	Jun. Assoc. M. M.	Oct. 1, 1901 April 6, 1904 June 19, 1918
Aegerter, Albert August. 501 Stock Exchange Bldg., St. Louis, Mo	Assoc. M. M.	Mar. 1, 1910 May 13, 1918
Auten, John Cummings. Prin. Asst. Engr., Southern Div., P. R. R., Room 409, Pennsylvania Bldg., Wilmington, Del		May 13, 1918
Bailey, Frank Harrison. Hamilton, Mont		Jan. 14, 1918
Baker, George Everett. Cons. Irrig. Engr.; City Engr., Whitehall, Mont	Assoc. M. M.	Sept. 2, 1914 June 19, 1918
Blackman, Charles Henry. Prin. Asst. Engr., L. & N. R. R., P. O. Box 22, Anchorage, Ky		April 16, 1918
Borden, Henry Percy. Care, Dept., Rys. and Canals, Ottawa, Ont., Canada		May 13, 1918
Bromley, Albert Henry, Jr. Chf. Engr., Bldg. Materials Div., Berger Mfg. Co., Canton, Ohio	Assoc. M.	Feb. 2, 1909 April 17, 1918
Brossman, Charles. Secy.-Treas., Indiana Eng. Soc.; Cons. Engr., 1616 Merchants Bank Bldg., Indianapolis, Ind.		June 18, 1918
Bruntlett, Eugene Harry. Constr. Engr., A. Guthrie & Co., Inc., Blue Island, Ill	Jun. Assoc. M. M.	June 6, 1905 June 30, 1910 June 19, 1918
Butters, John Henry. Chf. Engr. and Gen. Mgr., Hydro-Elec. Dept., Tasmanian Govt., Box 5, G. P. O., Hobart, Tasmania		Mar. 12, 1918
Chandler, Elbert Milam. Chf. Engr., Naches Selah Irrig. Dist., 602 Miller Bldg., Yakima, Wash	Assoc. M. M.	Oct. 1, 1912 June 19, 1918
Chorlton, William Harper. Care, Am. Bridge Co., 30 Church St., New York City		June 18, 1918
Cleverdon, Frederick Robert Wheeler. Contr. Engr.; Vice-Pres., Allen N. Spooner & Son, Inc., 50 Brookside Pl., New Rochelle, N. Y		May 13, 1918
Daniels, Thomas Remington Holden. Chf. Engr., Terre Haute, Indianapolis & East. Traction Co., 212 Traction Terminal Bldg., Indianapolis, Ind	Assoc. M. M.	Feb. 6, 1907 June 19, 1918
David, Thomas Hendricks. Asst. Chf. Engr., Indianapolis Traction & Terminal Co., 914 Traction Terminal Bldg., Indianapolis, Ind		June 18, 1918

MEMBERS (*Continued*)

		Date of Membership.
DAVIS, CHARLES MOSS. Engr. and Contr. (B. F. & C. M. Davis), 407 Reynolds Bldg., Fort Worth, Tex.	Jun. Assoc. M. M.	Jan. 3, 1907 Oct. 3, 1911 June 19, 1918
DAVIS, MEYER. Pacific Coast Mgr., Aspromet Co., 1007 Hobart Bldg., San Francisco, Cal.	Jun. Assoc. M. M.	Sept. 3, 1913 Aug. 31, 1915 May 13, 1918
EMERSON, FRANK COLLINS. Cons. Engr., Worland, Wyo.		May 13, 1918
FRANKLAND, FREDERICK HERSTON. Cons. Engr., Waddell & Son (Inc.), 35 Nassau St., New York City	Assoc. M. M.	May 31, 1916 Mar. 12, 1918
GREGORY, CHARLES EMERSON. Mt. Kisco, N. Y.	Jun. Assoc. M. M.	Oct. 6, 1896 Mar. 6, 1901 June 19, 1918
HAEHL, HARRY LEWIS. (Duryea, Haehl & Gilman), 1317 Humboldt Bank Bldg., San Francisco, Cal.	Jun. Assoc. M. M.	Oct. 6, 1903 July 9, 1906 June 19, 1918
HARDMAN, ROY CORDIS. Acting Supt., Northern Dist., Bldg. Div., Panama Canal, Box 5017, Cristobal, Canal Zone, Panama	Assoc. M. M.	Oct. 7, 1908 May 13, 1918
HAYES, JOHN EDWARD. Cons. Engr.; Chf. Engr., The Farmers Reservoir & Irrig. Co., 705 Ideal Bldg., Denver, Colo.		June 18, 1918
HEALD, JAMES HUGHES. Engr., Lassig Plant, Am. Bridge Co., Clybourn and Wrightwood Aves., Chicago, Ill.		May 13, 1918
HICKOK, CLIFTON EWING. Capt., Engr. R. C., Office, Chf. of Engrs., U. S. A., Room 4-336, Washington, D. C.	Jun. Assoc. M. M.	Dec. 6, 1910 May 28, 1912 Jan. 14, 1918
HUNT, CHARLES ADAMS. Civ. Engr., U. S. N. R. F., Yorktown, Va.	Assoc. M. M.	Oct. 4, 1905 May 13, 1918
JOHNSON, MARO. Asst. Engr., Ill. Cent. R. R., 1434 East 65th St., Chicago, Ill.	Assoc. M. M.	April 6, 1909 May 13, 1918
KEENAN, JOHN THOMAS. Maj., Engr. R. C., 28th Engrs., Woodbridge, Va.		Jan. 14, 1918
KING, WESLEY EUGENE. Cons. Engr. (The Toltz Eng. Co.), 1410 Pioneer Bldg., St. Paul, Minn.	Assoc. M. M.	Mar. 2, 1915 May 13, 1918
LEE, ROBERT HILEMAN. Care, Vang Constr. Co., 402 Mutual Home Bldg., Dayton, Ohio	Assoc. Assoc. M. M.	May 2, 1906 June 6, 1911 May 13, 1918
LUNDGREN, LEONARD. Capt., 116th Engrs., Army P. O. 714, Am. Exp. Forces, France	Jun. Assoc. M. M.	Feb. 4, 1908 July 9, 1912 May 13, 1918
McCOY, CHARLES EPHRAIM. Secy., West Virginia State Road Comm., 1519 Lee St., Charleston, W. Va.		May 13, 1918

MEMBERS (*Continued*)

		Date of Membership.
MARSHALL, CYRIL ERNEST DAVIS. 721 North Sargent Ave., Joplin, Mo.	Assoc. M. M.	Mar. 6, 1907 April 17, 1918
MILNER, WINFRED LEON. Chf. Engr., Potosi-Sucre Ry., Casilla 113, La Paz, Bolivia.	Assoc. M. M.	April 30, 1912 May 13, 1918
MOORE, FRANK COOK. Care, Am. Bridge Co., 30 Church St., New York City		May 13, 1918
MORAN, ROBERT BRECK. Geologist and Engr., 458 South Spring St., Los Angeles, Cal.	Jun. Assoc. M. M.	Sept. 1, 1908 June 6, 1911 June 19, 1918
MYERS, JOHN HAYS. Engr., Second Div., Public Service Comm., First Dist., 70 East 45th St., Room 2045, New York City	Jun. Assoc. M. M.	Dec. 5, 1893 Oct. 5, 1898 May 13, 1918
NEEL, ARTHUR WOOD. 1st Lieut., R. T. C., N. A., Headquarters, Transportation Dept., U. S. A. P. O. No. 717, Am. Exp. Forces, France (Res., 304 Princeton Ave., Birmingham, Ala.)		Jan. 14, 1918
NICHOLS, JOHN ROBERT. Engr. with Monks & Johnson of Boston, 82 Avon Hill St., Cambridge, Mass.	Jun. Assoc. M. M.	June 1, 1909 Sept. 3, 1913 May 13, 1918
PINNEY, JAMES CHARLES, JR. Dean, Coll. of Applied Science and Eng., Marquette Univ., Milwaukee, Wis.		April 16, 1918
PRIOR, JOHN CLINTON. Designing and Cons. Engr. (Braun, Fleming, Knollman & Prior); Chf. Cost Reports Engr., Bureau of Industrial Housing and Transportation, 613 G St., N. W., Washington, D. C.	Assoc. M. M.	Feb 6, 1912 May 13, 1918
REICHARDT, WALTER FREDERICK. Box 115, Watertown, Wis.	Jun. Assoc. M. M.	Jan. 31, 1905 July 10, 1907 Jan. 14, 1918
ROBBINS, HENRY CHANDLER. Archt. and Engr. (Densmore & LeClear), 88 Broad St., Boston, Mass.		June 18, 1918
ROHRBOUGH, ELMORE MARCELLUS. Pres. and Mgr., Rohrbough Eng. Co., 929 City National Bank Bldg., Omaha, Nebr.		June 18, 1918
SHAFER, CHARLES GEORGE. Box 155, Pitman, N. J.		April 16, 1918
SMITH, WILLIAM BEAUVAIS, JR. Asst. Engr., U. S. Engr. Dept., 327 Custom House, New Orleans, La.	Assoc. M. M.	June 30, 1911 April 17, 1918
STOCKWELL, RUPERT KENNEDY. Western Mgr., Robins Conveying Belt Co., 204 Newhouse Bldg., Salt Lake City, Utah	Assoc. M. M.	June 24, 1914 April 17, 1918
TUDBURY, WARREN CHAMBERLAIN. Expert Aide, Public Works Office, Navy Yard, Mare Island, Cal.	Assoc. M. M.	June 1, 1909 Mar. 12, 1918

MEMBERS (*Continued*)

		Date of Membership.
WALKER, EDWARD GEORGE. Lieut., R. N. V. R., 78 Cheyne Court, Chelsea, London, S. W. 3, England	Jun. Assoc. M. M.	April 2, 1907 Dec. 3, 1913 June 19, 1918
WILCOX, ERNEST HARDWICK. Capt., Engr. R. C., Care, Industrial Ry., Camp A. A. Humphreys, Va		Jan. 14, 1918

ASSOCIATE MEMBERS

ADAMS, GEORGE NORRIS. 800 Central Bldg., Los Angeles, Cal		Mar. 12, 1918
ARNOLL, KINGSLEY PARKHURST. Leading Draftsman, U. S. Navy Dept., Bureau of Yards and Docks (Res., 205 Iroquois Apartment House), Washington, D. C		April 16, 1918
ASHWORTH, FRANK KARR. Chf. Engr., Chevelier Corporation and Tamiami Ry., 900 Ave. C, Miami, Fla		June 18, 1918
BAKER, HAROLD WALLACE. 122 Vermont St., Rochester, N. Y	Jun. Assoc. M.	Mar. 5, 1912 May 13, 1918
BENNETT, CARROLL GUERNSEY. Water and Heat Engr., Public Utilities Comm., 618 Park Ave., Springfield, Ill		June 18, 1918
BERRY, STEPHEN CARTLAND. County Engr., Butte County, Belle Fourche, S. Dak		May 13, 1918
BEST, BYRON GRAY. Asst. Chf. Engr., Oliver Min. Co., Ironwood, Mich		May 13, 1918
BOOKWALTER, PARKER STANLEY. Supt. of Constr., The Dayton Lumber & Mfg. Co., 51 Mary Ave., Dayton, Ohio		May 13, 1918
BOOZ, HOWARD CRAWFORD. 21 West Spring Ave., Ardmore, Pa		May 13, 1918
BOSARD, RALPH. Asst. Engr., Morgan Eng. Co., 622 Goodwyn Inst., Memphis, Tenn		Jan. 14, 1918
BRENNAN, EDWARD MICHAEL. Care, Dept. of Public Works, Santo Domingo, P. O. Box 137, Santo Domingo, Dominican Republic		April 16, 1918
BROOK, ALEC EDWARD. Capt., Royal Engrs., B. E. F., France; Address, Totley Rise, Sheffield, England	Jun. Assoc. M.	Mar. 5, 1912 April 16, 1918
BUCHANAN, WARREN HENDERSON. Chf. Machinist Mate, U. S. N. R. F., U. S. Naval Training Camp, Gulfport, Miss.; Address, 1526 South 19th St., Birmingham, Ala		Jan. 14, 1918
BURTON, RICHARD CHEETHAM. Supt. of Bldgs., International Rys. of Central America, Guatemala, Guatemala		May 13, 1918
CHAPMAN, ARTHUR GROVER CLEVELAND. Constr. Engr., 75 Farragut Ave., Providence, R. I		Jan. 14, 1918

ASSOCIATE MEMBERS (*Continued*)

		Date of Membership.
Childs, John Chauncey. Acting Dist. Mgr., The Austin Co., 1026 Bulletin Bldg., Philadelphia, Pa		June 18, 1918
Clarke, John Lyell. Asst. San Engr., U. S. Public Health Service, Newport News, Va		June 18, 1918
Cohen, Jacob Xenab. Designing Engr., Syracuse Intercepting Sewer Board, 104 City Hall, Syracuse, N. Y	Jun. Assoc. M.	Oct. 3, 1911 April 17, 1917
Collins, Glenville Arthur. Cons. Engr.; Pacific Coast Mgr., Wellman-Seaver Morgan Co., 1317 L. C. Smith Bldg., Seattle, Wash		May 13, 1918
Cottrell, Clarke Copeland. State Highway Engr., Carson City, Nev		May 13, 1918
Craven, John Thomas. Chf. Engr., Hunkins Willis Lime & Cement Co., 4622 Westminster Ave., St. Louis, Mo		June 18, 1918
Crawford, Ivan Charles. Maj., U. S. N. G., 115th Engrs., Camp Kearny, Cal	Jun. Assoc. M.	Mar. 2, 1915 Jan. 14, 1918
Crenshaw, Bernard Lee. Box 191, Toccoa, Ga		May 13, 1918
Daly, John William. Lieut., Inf. R. C.; Asst. Engr., Public Service Comm., 1st Dist. (Res., 652 West 185th St.), New York City		May 13, 1918
Danzilli, Alfred Michael. Route Engr., Pittsburgh, Des Moines Steel Co., 807 Curry Bldg., Pittsburgh, Pa	Jun. Assoc. M.	Jan. 17, 1916 May 13, 1918
Davies, Herbert Arthur. Acting Supt., Highway Dept., Virginia Bridge & Iron Co., P. O. Box 925, Roanoke, Va	Jun. Assoc. M.	Mar. 14, 1916 April 16, 1918
Dierks, Louis Elmer. Asst. to Chf. Engr., Sauerman Bros., 1015 South Clinton Ave., Oak Park, Ill		June 18, 1918
Diffenderfer, Claude Orville. Capt., Engr. R. C., 534th Engrs., Camp Jackson, S. C.; Address, 522 Douglas St., Reading, Pa		June 18, 1918
Dodd, Joseph Holmes Lee. 2d Lieut., B. W. I. Reg., Burlington, St. Margaret's Bay, Jamaica		May 13, 1918
Douglass, Louis Rea. Capt., Q. M. R. C., 508 Woodlawn Rd., Roland Park, Baltimore, Md		June 18, 1918
Dow, Peter Staub. Asst. Prof. of Eng. and Graphics, Dartmouth Coll., Box 83, Hanover, N. H		June 18, 1918
Duryea, Robert Francis. 1246 Sacramento St., San Francisco, Cal		June 18, 1918
Eaton, Eugene Courtlandt. Supt., Lindsay-Strathmore Irrig. Dist., Lindsay, Cal		June 18, 1918
Edgecomb, Rex Edward. Purchasing Asst. of Mech. Equipment, Emergency Fleet Corporation (Res., 5844 Angora Terrace), Philadelphia, Pa	Jun. Assoc. M.	April 2, 1913 May 13, 1918

ASSOCIATE MEMBERS (*Continued*)

		Date of Membership.
Eiffert, Curt Henry. 661 Franklin St., Hamilton, Ohio..		April 16, 1918
Ellis, Thomas Pengelly. Engr., Volcan Land & Water Co., 3784 Thirty-first St., San Diego, Cal..........		May 13, 1918
Elting, Oscar Roelif. Asst. Engr., Akron City Water-Works, 540 Weber Ave., Akron, Ohio..............		June 18, 1918
English, Henry William. Res. Engr., Little River Drainage Dist., 416 Bellevue St., Cape Girardeau, Mo..................	Jun. Assoc. M.	Nov. 12, 1913 May 13, 1918
Esterly, Ward Benjamin. Contr. and Const. Engr., 500 New Call Bldg., San Francisco, Cal................		June 18, 1918
Everett, Ralph Burrows. Private, Co. F, 23d Engrs., Am. Exp. Forces, France; Address, 534 Stinard Ave., Syracuse, N. Y..............................	Jun. Assoc. M.	Nov. 28, 1916 April 16, 1918
Field, Arthur Maxwell. City Mgr. and Engr., 108 South Washington St., Winchester, Va.................		May 13, 1918
Fisher, Lawrence Machemer. San. Engr., U. S. Public Health Service, Washington, D. C.................		April 16, 1918
Fitzgerald, Gerald Chapman. 1st Lieut., Engr. R. C., 319th Engrs., Camp Fremont, Cal.; Address, 1223 Delaware Drive, Los Angeles, Cal..............	Jun. Assoc. M.	June 3, 1915 June 18, 1918
Forster, Arthur Oscar. Capt., Q. M. C., N. A., Army Supply Base, 59th St. and 1st Ave. (Res., 1617 Beverly Rd.), Brooklyn, N. Y.....................		Mar. 12, 1918
Franklin, Philip Augustus. Senior Structural Draftsman, Bridge Dept., City Engr.'s Office, 409 East 65th St., Seattle, Wash..............................	Jun. Assoc. M.	Jan. 2, 1912 May 13, 1918
Franzen, John Lavern. Div. Engr., Canada Land & Irrig. Co., Ltd., Travers, Alberta, Canada................		June 18, 1918
Fry, Albert Stevens. With Morgan Eng. Co., 622 Goodwyn Inst., Memphis, Tenn......................		June 18, 1918
Garlinghouse, Ralph Leman. Alum Rock Ave., San José, Cal...		June 18, 1918
Geib, George Albert. Capt., Engr. R. C., Co. A, 527th Engrs., Service Bn., Camp Upton, N. Y.; Address, 770 Como Ave., St. Paul, Minn..................		May 13, 1918
Gerner, Anson John. Asst. Engr., U. S. Reclamation Service, Provo, Utah............................		May 13, 1918
Gibson, Thomas Fenner. Box 324, Red Springs, N. C....		May 13, 1918
Grady, Paul Leo. Engr., Public Utilities Comm., State of Kansas, State House, Topeka, Kans...............		April 16, 1918
Griswold, Harold Wiley. Care, Eng. Dept., Board of Water Commrs., 1026 Main St., Room 702, Hartford, Conn............	Jun. Assoc. M.	May 7, 1913 May 13, 1918

ASSOCIATE MEMBERS (*Continued*)		Date of Membership.
Hadley, Allen Stacy. In Chg. of Tarvia Dept., The Barrett Co., 2429 Troost Ave., Kansas City, Mo.		June 18, 1918
Hall, Oliver Antrum. Capt., 23d Engrs., U. S. A., U. S. A. P. O. 708, Am. Exp. Forces, France		Nov. 27, 1917
Harder, Ernest Henry. 14 North 9th St., Newark, N. J.		May 13, 1918
Hawley, George William. Res. Engr., San Pablo Project, East Bay Water Co., Box 468, R. F. D. No. 1, Berkeley, Cal.	Jun. Assoc. M.	Sept. 2, 1914 May 13, 1918
Hayes, Reuben. Structural Engr., So. Ry., 1300 Pennsylvania Ave., Washington, D. C.		May 13, 1918
Hedrick, Wyatt Cephas. Pres., W. C. Hedrick Const. Co., Dallas, Tex.		May 13, 1918
Hendrickson, John Norcom. Chf. Engr., Pan-American Petroleum Co., Box 524, Ojai, Cal.		April 16, 1918
Higgins, Thomas Carol. Insp. of Constr., Norfolk Navy Yard, Norfolk, Va.	Jun. Assoc. M.	Nov. 3, 1915 June 18, 1918
Hinrichs, Adolf. 179 Lewis Ave., Brooklyn, N. Y.		June 18, 1918
Hirsch, Herman David. Structural Steel Draftsman, Am. Bridge Co., 30 Church St., New York City		June 18, 1918
Hohl, Albert Keller. Contr. Mgr., Philadelphia Office, Lewis F. Shoemaker & Co., 5145 North Camac St., Philadelphia, Pa.		April 16, 1918
Horton, Philip Zell. (Terhune & Horton), 401 Central National Bank Bldg., Peoria, Ill.	Jun. Assoc. M.	May 6, 1914 April 16, 1918
Howard, William James. Gen. Supt., Kelly Atkinson Co., 5548 Wayne Ave., Chicago, Ill.		May 13, 1918
Huber, Albert, Jr. Engr. and Estimator, Clinton Constr. Co., 140 Townsend St., San Francisco, Cal.		June 18, 1918
Hughes, George Alfred. Asst. Civ. Engr., The New York Edison Co., 256 Brooklyn Ave., Brooklyn, N. Y.		May 13, 1918
Hunter, Joseph Greenwood. Asst. Engr., U. S. Geological Survey, 210 Federal Bldg., Pueblo, Colo.		Nov. 27, 1917
Husselman, Roy. Cons. Engr. (F. W. Ballard & Co.), 12200 Clifton Boulevard, Lakewood, Ohio		June 18, 1918
Huttenloch, Morton Walker. Prin. Asst. Engr., Div. of Bridges and Grade Crossings, State of New Jersey Board of Public Utility Commrs., 76 Church St., Montclair, N. J.		April 16, 1918
Jones, George Wiley. Asst. Road Commr., Los Angeles County, 3334 Elthea St., Los Angeles, Cal.		June 18, 1918
Jones, Paul Sidney. Battery No. 19, F. A. O. T. C., Camp Zachary Taylor, Ky.	Jun. Assoc. M.	Dec. 3, 1912 May 13, 1918

ASSOCIATE MEMBERS (*Continued*)

		Date of Membership.
Jones, Samuel Thomas, Jr. Supt., Hardaway Contr. Co., Bridgewater, N. C.		June 18, 1918
Kirby, Luther Hill. Capt., Engr. R. C.; Address, Care, John W. Hunter, Berkeley Springs, W. Va.		May 13, 1918
Klepinger, Howard Robert. Water Supply Engr., The Am. Steel & Wire Co., 5311 Magnet Ave., Suite No. 2, Cleveland, Ohio		May 13, 1918
Kone, Samuel Louis. Chf. Engr., Mexican Gulf Oil Co., Apartado 106, Tampico, Tamp., Mexico		April 16, 1918
Kruse, Otto V. 634 Chilton Ave., Niagara Falls, N. Y.		May 13, 1918
Lacher, Walter Scott. Associate Eng. Editor, *Railway Age Gazette;* Managing Editor, *Railway Maintenance Engineer*, 440 North Spring Ave., La Grange, Ill.		May 13, 1918
Lapham, John Raymond. Asst. Prof. of Civ. Eng., George Washington Univ., 1829 G St., N. W., Washington, D. C.	Jun. Assoc. M.	Nov. 8, 1909 April 16, 1918
Larson, Reuben Lawrence. Prof. of Ry. and Bridge Eng., Chinese Govt. Univ., Peking, China		May 13, 1918
LaRue, Luther. Asst. City Engr., 565 Marview Ave., Akron, Ohio		June 18, 1918
Lashmet, Luther Clyne. Chf. Draftsman, Waddell & Son, 800 Graphic Arts Bldg., Kansas City, Mo		April 16, 1918
Latimer, Hugh. Valuation Dept., N. Y. C. R. R., Room 3754, Grand Central Terminal, New York City		Mar. 12, 1918
Laurence, Paul Arthur. Vice-Pres. and Treas., Laurence Constr. Co., 544 Builders Exchange Bldg., Minneapolis, Minn.		May 13, 1918
Learned, Albert Preisach. 1st Lieut., San C., N. A., Co. 28, Bn. 7, Camp Greenleaf, Chickamauga Park, Ga	Jun. Assoc. M.	Dec. 6, 1910 May 13, 1918
Lehner, Walter John. County Highway Engr. and County Surv., Macomb County, Mt. Clemens, Mich.		June 18, 1918
Long, Verne Vere. Cons. Engr., Oklahoma City; Office Engr., Benham Eng. Co., 1300 Colcord Bldg., Oklahoma, Okla.		May 13, 1918
Loveland, Charles Dubuisson. Dist. Mgr., Trussed Concrete Steel Co., 2541 Oliver Bldg., Pittsburgh, Pa.		May 13, 1918
McCoy, Curtis John. (McCoy & Taylor), Box 1033, Wichita, Kans.		June 18, 1918
McGee, Harold Gilbert. 1st Lieut., San. C., N. A., Detachment San. Corps, Camp Jackson, Columbia, S. C.	Jun. Assoc. M.	Dec. 3, 1913 April 16, 1918
Maloy, Thomas Franklin. Div. Engr., West Virginia State Road Comm., 10th Dist., Landisburg, W. Va.		June 18, 1918

ASSOCIATE MEMBERS (*Continued*)

		Date of Membership.
Melin, Reynold Ferdinand. 1st Lieut., Ord. R. C., 1269 New Hampshire Ave., Washington, D. C		Nov. 27, 1917
Menke, William. Stewart House, Athens, N. Y	Jun. Assoc. M.	Dec. 6, 1910 April 16, 1918
Middleton, Raymond Thomas. Care, Roberts & Schaefer Co., 2064 McCormick Bldg., Chicago, Ill		May 13, 1918
Milkowski, Victor John. 2d Lieut., Engr. R. C., Camp Humphreys, Va.; Address, 139 Prospect St., Schenectady, N. Y	Jun. Assoc. M.	Nov. 28, 1916 June 18, 1918
Miller, John Owen. 2d Lieut., N. A., 10th Casual Detachment, Inf. Replacement Camp, Camp Lee, Va	Jun. Assoc. M.	July 2, 1913 Jan. 14, 1918
Milton, Samuel Lawrence. Engr. and Contr., 19 Westminster Rd., Roxbury, Mass		May 13, 1918
Monaghan, John Ripley. Asst. to Div. Engr., Rapid Transit Subway Constr. Co., 12 Eighteenth St., Elmhurst, N. Y		April 16, 1918
Moots, Elmer Earl. Civ. and Mech. Engr., Agricultural Products Corporation, Continental, Ariz	Assoc. Assoc. M.	May 31, 1916 April 17, 1918
Morelock, John Earl. Lieut., Engr. R. C., Care, Engr. Purchasing Officer, U. S. P. O. 702, Am. Exp. Forces, France		June 11, 1917
Mottier, Charles Halvatious. Asst. Engr., Ill. Cent. R. R., 1403 East 69th Pl., Chicago, Ill		June 18, 1918
Nagler, Floyd August. Private, Science and Research Dept., A. S. Sig. C., Meteorological Section, Agricultural and Mech. Coll. of Texas, College Station, Tex	Jun. Assoc. M.	Mar. 14, 1916 May 13, 1918
Norelius, Lewis Magnus. 56 Davenport, Detroit, Mich		June 18, 1918
Norton, Paul Willard. Architectural Engr., Maginnis & Walsh, 38 Windsor Rd., Wellesley Hills, Mass		May 13, 1918
Olmsted, Roger Wolcott. Chf. Engr., South San Joaquin Irrig. Dist., Manteca, Cal		June 18, 1918
Outwater, Herbert Gregor. Capt., San. C., N. A.; Camp Engr. Officer, Camp Greenleaf, Chickamauga Park, Ga.		Jan. 14, 1918
Paaswell, George. Section Engr., Public Service Comm., First Dist., 212 West Fordham Rd., New York City		June 18, 1918
Packard, Francis Chapman. Chf. Engr., Sun Co. and Sun Pipe Line Co., 3 Lightfoot Apartments, Beaumont, Tex		May 13, 1918
Paine, Rennick Rubenell. 353 South 8th St., Chillicothe, Ill		Jan. 14, 1918

ASSOCIATE MEMBERS (*Continued*)

		Date of Membership.
PAINTER, PENNELL CHURCHMAN. 1st Lieut., Engr. R. C., Co. D, 524th Engrs., Service Bn., Camp A. A. Humphreys, Va.		Mar. 12, 1918
PAULSEN, CARL GUSTAV. Dist. Engr., Dept. of the Interior, U. S. Geological Survey, 521 Post Office Bldg., Atlanta, Ga.		May 13, 1918
PETERSON, JOHN. Res. Engr., Ry. Maintenance, Soo Line, Enderlin, N. Dak.		June 18, 1918
PHILLIPS, WALTER BELLEVILLE. Capt., Q. M. C., N. A., 1422 Massachusetts Ave., Washington, D. C.		June 18, 1918
PORTERFIELD, ROY ALBERT. Asst. Field Engr., Interstate Commerce Comm., 6th Floor, Interstate Bldg., Kansas City, Mo.		May 13, 1918
PROCTOR, RALPH SAWYER. 6451 Blackstone Ave., Chicago, Ill.		June 18, 1918
REIDPATH, ELBERT HUME. (Robert J. Reidpath & Son), 64 Builders Exchange, Buffalo, N. Y.	Jun. Assoc. M.	Sept. 2, 1914 May 13, 1918
REVELL, JOHN. 9 Maryland Ave., Annapolis, Md.		Nov. 27, 1917
RICKARD, JOHN PHILIP. 155 Main St., West, Room 512, Rochester, N. Y.		Mar. 12, 1918
RINEY, ARTHUR HERBERT. Capt., Engr., R. C., Co. A, 28th Engrs., Am. Exp. Forces, France		Mar. 12, 1918
RITCHIE, JOHN MILTON. Capt., Q. M. R. C., 7th and B Sts., S. W., Washington, D. C.	Assoc. Assoc. M.	Aug. 31, 1915 April 17, 1918
ROBERG, RALPH MASON. 1902 West 21st St., Los Angeles, Cal.		April 16, 1918
ROBERTSON, ROGER ROCKFORD. Asst. Engr., U. S. Reclamation Service, Grand Valley Project, Grand Junction, Colo.		June 18, 1918
ROWLAND, HERBERT ARLON. County Surv. and County Engr., McPherson County, McPherson, Kans.		June 18, 1918
RUHLING, GEORGE HUTZE. 921 East 7th St., Flint, Mich.	Jun. Assoc. M.	Mar. 13, 1917 May 13, 1918
SCHILLING, ALEXANDER CHARLES. Care, U. S. Geological Survey, Lawrenceville, Va.		June 18, 1918
SEAMAN, DANIEL HENRY. Designing Engr., Hay Foundry & Iron Works, 15 Madison Sq., North, New York City	Jun. Assoc. M.	Dec. 3, 1912 May 13, 1918
SEWARD, HAROLD CLINTON. Gen. Supt. of Constr., Bayly Hipkins, Inc. (Res., 623 Ave. L), Brooklyn, N. Y.	Jun. Assoc. M.	Jan. 15, 1917 April 16, 1918
SEYMOUR, CLYDE JOHN. Cassidy, Vancouver Island, B. C., Canada		June 18, 1918

ASSOCIATE MEMBERS (*Continued*)

		Date of Membership.
Shapiro, Samuel. Asst. Engr., Grade E, Bureau of Topography, Room 2100, Municipal Bldg., New York City		May 13, 1918
Silvernail, Alfred Kimberly. 1st Lieut., Q. M. C., N. A., Edgewood Arsenal, Edgewood, Md		May 13, 1918
Smith, William Augustus. Village Engr., Box 33, Tuckahoe, N. Y		April 16, 1918
Snowden, Russell Elstner. Div. Highway Engr., North Carolina State Highway Comm., 112 Carolina Ave., Goldsboro, N. C		June 18, 1918
Stephens, George William, Jr. Chf. Engr., The Dundalk Co., 704 Gladstone Ave., Roland Park, Md	Jun. Assoc. M.	April 2, 1912 May 13, 1918
Street, John Zadok. Private, Specialist Detachment, Co. A, 26th Engrs., Am. Exp. Forces, France; Care, Thomas A. Gilkey, Mercantile Bldg., New Castle, Pa	Jun. Assoc. M.	Sept. 2, 1914 Mar. 12, 1918
Sumner, Merton Rogers. Mech. Dept., The Fred T. Ley Co., Inc., Box 20, Wilmington, Del		May 13, 1918
Tattersall, Harold. With Charles W. Leavitt, 10 Sheffield St., Jersey City, N. J		June 18, 1918
Timberlake, Seth Martin. Asst. Engr., Public Service Comm., 1st Dist., 2107 Bedford Ave., Brooklyn, N. Y	Jun. Assoc. M.	Mar. 1, 1910 May 13, 1918
Townsend, Tulloch McCosh. Supt., Bureau of Water, 477 Franklin St., Schenectady, N. Y		June 18, 1918
Trudeau, James Arthur. 1342 Virginia St., Berkeley, Cal.		June 18, 1918
Van Deusen, Edgar Allchin. Chf. Draftsman, Southern Power Co., Charlotte, N. C		May 13, 1918
Waller, Alexander Charles. 1st Lieut., Engr. R. C., 22d Engrs., Fort Benjamin Harrison, Ind. (Res., 264 East Curtice St., St. Paul, Minn.)		April 16, 1918
Ward, Edward Ashton. Engr. of Constr., and Treas., Wm. H. Lutton Co., 267 Kearney Ave., Jersey City, N. J	Jun. Assoc. M.	Oct. 5, 1909 June 18, 1918
Welsh, Russell Dutton. Private, Co. F, 115th Engrs., Camp Kearney, Cal.; Address, 721 Reservoir St., Baltimore, Md		June 18, 1918
Wheeler, Walter Hall. (Chas. H. Wheeler & Son), 1112 Metropolitan Life Bldg., Minneapolis, Minn		June 18, 1918
Wilder, Ellwood Coggeshall. 12 Steiner St., San Francisco, Cal	Jun. Assoc. M.	June 30, 1910 May 13, 1918
Winsor, Harry Draper. Asst. Engr., Public Service Comm., 374 Livermore Ave., Westerleigh, N. Y	Jun. Assoc. M.	Mar. 1, 1910 May 13, 1918
Woodin, Earl Belmont. Structural Steel Checker, Am. Bridge Co., 502 Maplewood Ave., Ambridge, Pa		May 13, 1918

ASSOCIATE MEMBERS (*Continued*)

	Date of Membership.
YOST, FRANK DENNETT. Surv., U. S. Forest Service, Albuquerque, N. Mex.	April 16, 1918
YOUNG, CHARLES CLINTON. Asst. Engr., Valuation Dept., United Railroads of San Francisco; McKinley Court Apartments, Apartment No. 10, Berkeley, Cal.	June 18, 1918
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RITOW, HERMAN. 302d Engrs., Co. B, Am. Exp. Forces, France.

ROGERS, LESTER CUSHING. 333d F. A., Camp Grant, Ill.

JUNIORS (*Continued*)

RYLAND, REIS JOSEPH. 2d Lieut., Sig. C., U. S. A., 323d Field Sig. Bn., Camp Morse, Leon Springs, Tex.; Care, San José Water-Works, 374 West Santa Clara St., San José, Cal.

ST. JOHN, ROYAL UPSON. 2d Lieut., Sig. R. C., A. S.; Information Officer, 95th Aero Squadron, Am. Exp. Forces, France (Res., R. R. No. 1, Redwood City, Cal.)

SCUDDER, CHARLES MORRISON. Capt., Co. E, 107th Engrs., Am. Exp. Forces, France.

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SEELYE, SETH HENESS. Co. G, 23d Engrs., Am. Exp. Forces, France.

SEXTON, GEORGE FRANCIS. Sergeant, 1st Class; Engr. Superv., Camp Q. M.'s Office, Camp Jackson, Columbia, S. C.

SMITH, RICHARD BENNETT. Meteorological Section, A. S. Sig. C., Agricultural and Mech. Coll. of Texas, College Station, Tex.

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WEBER, CHARLES MARIA. West's Lane, Stockton, Cal.

WHITNEY, JOHN THAD. 2d Lieut., F. A. R. C., 2d Corps, Artillery Park, Camp Jackson, Columbia, S. C.

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WONG, JICK GAM. Res. Engr., Sections 7 and 10, Hankow-Ichang Ry., Han-I Ry. Office, Tsaoshih, Hupeh, China.

YEREANCE, ALEXANDER WOODWARD. 1st Lieut., Co. F, 305th Engrs., Am. Exp. Forces, France.

REINSTATEMENTS

MEMBERS	Date of Reinstatement.
WATT, DAVID ALEXANDER	June 18, 1918

ASSOCIATE MEMBERS	
WILLS, ARTHUR JOHN	June 18, 1918

RESIGNATIONS

JUNIORS	Date of Resignation.
IRWIN, WILLIAM CLARK	April 16, 1918

DEATHS

ALLEN, CALVIN HARLOW. Elected Member, September 7th, 1887; died July 13th, 1918.

ARMSTRONG, ROBERT STUART. Elected Associate Member, February 6th, 1907; died July 15th, 1918.

BUCKWALTER, HARRIS DANIEL. Elected Associate Member, May 31st, 1916; killed in action in France, May 12th, 1918.

CHAMBERS, HERBERT JAMES. Elected Associate Member, November 5th, 1902; Member, January 3d, 1911; died May 20th, 1918.

COBURN, HOWARD LINCOLN. Elected Member, March 5th, 1912; died June 19th, 1918.

GOODFELLOW, JAMES GORDON. Elected Junior, September 3d, 1913; Associate Member, October 9th, 1917; killed in action in France, March 23d, 1918.

HILL, WILLIAM RYAN. (*Director.*) Elected Member, July 1st, 1891; died June 16th, 1918.

LINDBERY, CHARLES ARTHUR. Elected Member, October 1st, 1913; date of death unknown.

MCMATH, ROBERT EMMET. Elected Member, March 3d, 1880; date of death unknown.

MARBURG, EDGAR. Elected Member, October 6th, 1897; died June 27th, 1918.

MAYHEW, ALFRED BOARDMAN. Elected Associate Member, November 8th, 1909; Member, January 18th, 1916; died May 12th, 1918.

MORDECAI, AUGUSTUS. Elected Member, February 1st, 1893; died July 28th, 1918.

NEHER, CLARENCE RUFUS. Elected Member, June 4th, 1902; died May 12th, 1918.

ODELL, RUTLEDGE IRVING. Elected Associate, October 1st, 1895; died March 25th, 1918.

SACKETT, JOHN WARREN. Elected Member, May 2d, 1894; died July 3d, 1918.

SUTERMEISTER, ARNOLD HENRY. Elected Member, June 3d, 1902; died June 29th, 1918.

WAGNER, BERNARD MATTHEW. Elected Associate Member, May 3d, 1899; Member, December 1st, 1903; died June 8th, 1918.

WATERBURY, LESLIE ABRAM. Elected Associate, November 7th, 1906; Associate Member, June 30th, 1910; Member, September 3d, 1913; died June 15th, 1918.

Total Membership of the Society, August 8th, 1918, 8 830.

MONTHLY LIST OF RECENT ENGINEERING ARTICLES OF INTEREST

(May 1st to July 20th, 1918)

NOTE.—*This list is published for the purpose of placing before the members of this Society, the titles of current engineering articles, which can be referred to in any available engineering library, or can be procured by addressing the publication directly, the address and price being given wherever possible.*

LIST OF PUBLICATIONS

In the subjoined list of articles, references are given by the number prefixed to each journal in this list:

(2) *Journal,* Engrs. Club of Phila., Philadelphia, Pa.
(3) *Journal,* Franklin Inst., Philadelphia, Pa., 50c.
(4) *Journal,* Western Soc. of Engrs., Chicago, Ill., 50c.
(5) *Transactions,* Engineering Institute of Canada, Montreal, Que., Canada.
(6) *Journal,* Am. Inst. of Archts., Washington, D. C., 50c.
(8) *Stevens Indicator,* Hoboken, N. J., 50c.
(9) *Industrial Management,* New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, 432 Fourth Ave., New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News-Record,* New York City, 15c.
(15) *Railway Age,* New York City, 15c.
(16) *Engineering and Mining Journal,* New York City, 15c.
(17) *Electric Railway Journal,* New York City, 10c.
(18) *Railway Review,* Chicago, Ill., 15c.
(19) *Scientific American Supplement,* New York City, 10c.
(20) *Iron Age,* New York City, 20c.
(21) *Railway Engineer,* London, England, 1s. 2d.
(22) *Iron and Coal Trades Review,* London, England, 6d.
(24) *American Gas Engineering Journal,* New York City, 10c.
(25) *Railway Mechanical Engineer,* New York City, 20c.
(26) *Electrical Review,* London, England, 4d.
(27) *Electrical World,* New York City, 10c.
(28) *Journal,* New England Water-Works Assoc., Boston, Mass., $1.
(29) *Journal,* Royal Society of Arts, London, England, 6d.
(32) *Mémoires et Compte Rendu des Travaux,* Soc. Ing. Civ. de France, Paris, France.
(33) *Le Génie Civil,* Paris, France, 1 fr.
(36) *Cornell Civil Engineer,* Ithaca, N. Y.
(42) *Proceedings,* Am. Inst. Elec. Engrs., New York City, $1.
(43) *Annales des Ponts et Chaussées,* Paris, France.
(45) *Coal Age,* New York City, 10c.
(46) *Scientific American,* New York City, 15c.
(47) *Mechanical Engineer,* Manchester, England, 3d.
(54) *Transactions,* Am. Soc. C. E., New York City, $12.
(55) *Transactions,* Am. Soc. M. E., New York City, $10.
(56) *Transactions,* Am. Inst. Min. Engrs., New York City, $6.
(57) *Colliery Guardian,* London, England, 5d.
(58) *Proceedings,* Engrs.' Soc. W. Pa., 2511 Oliver Bldg., Pittsburgh, Pa., 50c.
(59) *Proceedings,* American Water-Works Assoc., Troy, N. Y.
(60) *Municipal and County Engineering,* Indianapolis, Ind., 25c.
(61) *Proceedings,* Western Railway Club, 225 Dearborn St., Chicago, Ill., 25c.
(62) *American Drop Forger,* Thaw Bldg., Pittsburgh, Pa., 10c.
(63) *Minutes of Proceedings,* Inst. C. E., London, England.
(64) *Power,* New York City, 5c.
(65) *Official Proceedings,* New York Railroad Club, Brooklyn, N. Y., 15c.
(66) *Gas Journal,* London, England, 6d.
(67) *Cement and Engineering News,* Chicago, Ill., 25c.
(71) *Journal,* Iron and Steel Inst., London, England.
(71*a*) *Carnegie Scholarship Memoirs,* Iron and Steel Inst., London, England.
(72) *American Machinist,* New York City, 15c.
(73) *Electrician,* London, England, 18c.
(74) *Transactions,* Inst. of Min. and Metal., London, England.
(75) *Proceedings,* Inst. of Mech. Engrs., London, England.
(77) *Journal,* Inst. Elec. Engrs., London, England, 5s.
(83) *Gas Age,* New York City, 15c.
(85) *Proceedings,* Am. Ry. Eng. Assoc., Chicago, Ill.
(86) *Engineering and Contracting,* Chicago, Ill., 10c.

(87) *Railway Maintenance Engineer,* Chicago, Ill., 10c.
(89) *Proceedings,* Am. Soc. for Testing Materials, Philadelphia, Pa., $5.
(90) *Transactions,* Inst. of Naval Archts., London, England.
(91) *Transactions,* Soc. Naval Archts. and Marine Engrs., New York City.
(92) *Bulletin,* Soc. d'Encouragement pour l'Industrie Nationale, Paris, France.
(93) *Revue de Métallurgie,* Paris, France, 4 fr. 50.
(96) *Canadian Engineer,* Toronto, Ont., Canada, 10c.
(98) *Journal,* Engrs. Soc. Pa., Harrisburg, Pa., 30c.
(99) *Proceedings,* Am. Soc. of Municipal Improvements, New York City, $2.
(100) *Professional Memoirs,* Corps of Engrs., U. S. A., Washington, D. C., 50c.
(101) *Metal Worker,* New York City, 10c.
(103) *Mining and Scientific Press,* San Francisco, Cal., 10c.
(104) *The Surveyor and Municipal and County Engineer,* London, England, 6d.
(105) *Chemical and Metallurgical Engineering,* New York City, 25c.
(106) *Transactions,* Inst. of Min. Engrs., London, England, 6s.
(107) *Schweizerische Bauzeitung,* Zürich, Switzerland.
(109) *Journal,* Boston Soc. C. E., Boston, Mass., 50c.
(110) *Journal,* Am. Concrete Inst., Philadelphia, Pa., 50c.
(111) *Journal of Electricity,* San Francisco, Cal., 25c.
(113) *Proceedings,* Am. Wood Preservers' Assoc., Baltimore, Md.
(114) *Journal,* Institution of Municipal and County Engineers, London, England, 1s. 6d.
(115) *Journal,* Engrs.' Club of St. Louis, St. Louis, Mo., 35c.
(116) *Blast Furnace and Steel Plant,* Pittsburgh, Pa., 15c.
(117) *Engineering and Cement World,* Chicago, Ill.
(118) *Times Engineering Supplement,* London, England, 2d.

LIST OF ARTICLES

Bridges.

Moving Loads on Railway Underbridges.* William Beau Farr. (63) Vol. 202, 1916.
Pier-Foundations of the Wauganui Bridge, New Zealand.* Robert West Holmes. (63) Vol. 202, 1916.
The Reconstruction of Koari Bridge, Great Indian Peninsula Railway.* Thomas Christie Hood. (63) Vol. 202, 1916.
Keadby Bridge.* James Benjamin Ball. (63) Vol. 203, 1916.
Cost of Constructing Concrete Arch Bridge over Platte River in Nebraska. Geo. K. Leonard. (86) Feb. 27.
Methods of Maintaining and Repairing Old Highway Bridges.* (86) Feb. 27.
The Design of a Three-Hinged Arch.* P. H. Chen. (36) Mar.
Continuous Trusses of Silicon Steel Feature New Allegheny River Bridge.* (13) May 2.
Modern Drawbridges Attain Great Weights and Spans. (13) May 2.
Esthetics in Bridge Design.* J. A. L. Waddell. (18) May 18.
Tunnels *vs.* Bridges. (19) May 18.
Bridge Abutment has Pier Footings and Curved Wings.* Jonathan Jones. (13) May 23.
Don River Bascule Bridge, Toronto.* George T. Clark. (96) May 23.
The Principal Bridges of the World—a Comparison.* (12) Serial beginning May 24.
Concrete Bridge at Grand Mere, Que.* (117) June 1.
The Longest Possible Bridge Spans.* Charles Evan Fowler. (46) June 1.
Concrete Viaduct at St. Louis has Simple Details.* Charles W. Martin. (13) June 6.
Oregon-Washington Railway Separates Grades for Three Miles at Portland.* (13) June 6.
Method and Cost of Filling in High Trestles on Southern Pacific Ry. W. E. Burns. (86) June 19.
Recent Reinforced Concrete Highway Bridge Work in Ontario.* G. Graham Reid. (From an article in *The Contract Record.*) (86) June 26.
Foundations, Forms and Concrete Distribution Mark Bridge Construction.* Edward W. Stearns. (13) July 11.
Calcul des Voutes en Béton Armé.* L. Robert de la Mahotière. (33) Mar. 23.
Pont Basculant de 42 Mètres de Portée sur le Canal de Trollhättan (Suède).* A. Goupil. (33) May 18.

Electrical.

The Mechanical Problem of Electric-Power Transmission-Line Conductors.* Arthur Thomas Arnall. (63) Vol. 201, 1916.
Earths on Three-Phase Systems.* George Gladman Braid. (63) Vol. 202, 1916.

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* Illustrated.

Electrical—(Continued).

The Mechanical Working of Lead-Covered Underground Telephone Cables.* Charles Frederick Street. (63) Vol. 202, 1916.
The Electron Theory.* William Albert Noyes. (3) Jan.
Military Searchlights.* Roger Haydock. (100) Mar.
The Development of an Efficient Earthing System.* J. P. Forster. (Paper read before Assoc. of Min. Elec. Engrs.) (22) Mar. 29.
The Evolution of the Thermionic Valve.* R. L. Smith-Rose. (77) Apr.
Switchgear Standardization.* Charles C. Garrard. (77) Apr.
Electrical Inter-connection of the Aberdare and Rhymney Valley Collieries of the Powell Duffryn Steam Coal Company, Limited. (22) Apr. 5.
Electric Winding Engines.* John F. Perry. (Paper read before National Assoc. of Colliery Managers and Associates of Min. Elec. Engrs.) (73) Apr. 5.
Elementary Principles of Continuous-Current Armature Winding.* F. M. Denton. (73) Apr. 5.
Current Limiting Reactances.* (12) Apr. 12.
Notes on the Extending of Colliery Three-Phase Electrical Power Plant. L. Fokes. (22) Apr. 12.
Notes on the Maintenance of Turbo Alternators.* L. Fokes. (57) Apr. 12.
The Commutator Machine as the Standard Single-Phase Type.* (Abstract of paper read before Assoc. of Supervising Electricians.) (73) Serial beginning Apr. 19.
Performance of Polyphase Induction Motors.* Justin Lebovici. (27) Apr. 27.
Standardization of Overhead Construction.* H. E. Wulfing. (27) Apr. 27.
Current-Transformer Connections.* W. R. Woodward. (64) Apr. 30.
Electric Skip Hoists for Blast Furnaces.* David L. Lindquist. (First part of paper read before Pittsburgh Section A. I. S. E. E.) (116) May.
Lightning Arrester Spark Gaps.* Chester T. Allcutt. (42) May.
Pre-charged Condensers in Series and in Parallel.* V. Karapetoff. (42) May.
Standardized Occupations and Rates. W. D. Stearns. (9) May.
Steel Industry Belt Drive Applications.* Charles A. Hirschberg. (116) May.
Sustained Short-Circuit Phenomena and Flux Distribution of Salient-Pole Alternators.* N. S. Diamant. (42) May.
Telautographs Expedite Steel Production.* H. C. Snyder. (116) May.
The Control of Large Amounts of Power.* E. B. Wedmore. (77) May.
Tubular Earths for Lightning Conductors.* Killingsworth Hedges. (26) May 3.
Installation and Care of Reactors.* M. E. Skinner. (27) May 4.
Six-Unit Station will Develop 165 000 Kw.* (27) May 4.
Special Transmission-Line Problem.* (27) May 4.
Central-Station Heating in Detroit.* J. H. Walker. (64) May 7.
Requirements, Operation and Maintenance of Colliery Power Station Switchboards.* L. Fokes. (57) May 10.
Determining of Load Centers of Circuits.* Terrell Croft. (64) May 14.
An Electrolytic Metering Can.* (73) May 17.
Electric Ship Propulsion by the Ljunström Turbine.* (26) May 17.
Flickering of Electric Lamps.* K. Simons. (Abstract of article in *Elektrotechnische Zeitschrift.*) (73) May 17.
Some Notes on Loop Tests for Fault Localisation. G. W. Stubbins. (73) May 17.
Industrial-Lighting Curtailment.* C. E. Clewell. (72) May 23.
A Note on the Relation of the Audibility Factor of a Shunted Telephone to the Antennæ Circuit as Used in the Reception of Wireless Signals. Balth. Van Der Pol. (Abstract of article in *Philosophical Magazine.*) (73) May 24.
Power Factor and Its Improvement. E. W. Dorey. (73) Serial beginning May 24.
Rolling Mills and the Electric Drive. L. Rothera. (Abstract of paper read before Manchester Assoc. of Engrs.) (73) May 24.
Some Practical Considerations on Electrical Engineering. Chris. Jones. (Abstract of paper read before South Wales Inst. of Engrs.) (57) May 31.
Electricity as a Substitute for Natural Gas for Heating Purposes. Frank Thornton. (58) Apr.
Aerial Cable Construction for Electric Power Transmission.* E. B. Meyer. (42) June.
Application of Theory and Practice to the Design of Transmission Line Insulators.* G. I. Gilchrest. (42) June.
Method of Symmetrical Co-Ordinates Applied to the Solution of Polyphase Networks.* C. L. Fortescue. (42) June.
Protection from Flashing for Direct Current Apparatus.* J. J. Linebaugh and J. L. Burnham. (42) June.
The Oxide Film Lightning Arrester.* Charles P. Steinmetz. (42) June.
The Oxide Film Lightning Arrester.* Crosby Field. (42) June.
New Turbine Plant at Hull.* (22) June 7.
Wave Velocity and Capacity of Horizontal Helices in Wireless Telegraphy and Transmission Line Protective Apparatus.* A. Press. (73) June 7.

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* Illustrated.

Electrical—(Continued).

Computing the Speed of Receiving a Telegraphic Message Through Submarine Cables.* J. Rhymer-Jones. (26) June 14.
Concrete Poles are in the Process of Evolution.* Charles Rufus Harte. (17) June 15.
Dipping and Baking Railway Motors Will Decrease Troubles.* J. V. Dobson. (17) June 15.
Flywheel Equalizing Generator is Economical for Ore Dock.* (117) June 15.
Selecting Lightning Arrester Types to Suit Requirements.* Q. A. Brackett. (17) June 15.
Electric Power for Nitrogen Fixation. E. Kilburn Scott. (42) July.
Reactance of Synchronous Machines and its Applications. R. E. Doherty and O. E. Shirley. (42) July.
Split-Conductor Cable-Balanced Protection. W. H. Cole. (42) July.
The Design of Transpositions for Parallel Power and Telephone Circuits. Harold S. Osborne. (42) July.
Synchronous Motors in Rock Crushing Plants and Cement Mills.* Will Brown. (117) July 1.
The Electrical Study Course—Armature Reaction.* (64) July 2.
Changing from Isolated to Central Station Power.* Frank Huskinson. (45) July 6.
Keeping Direct-Current Apparatus from Flashing.* (17) July 6.
Power Station Earth Connections.* P. H. Adams. (64) July 9.
A Large Electric Crane.* H. T. Stuckey. (72) July 11.
L'Institut Electrotechnique et de Mécanique Appliquée de l'Université de Toulouse.* C. Camichel and D. Eydoux. (33) Apr. 27.
Le Viellissement des Isolateurs en Porcelaine.* (33) May 18.

Marine.

Buoyancy and Stability of Submarines.* William Hovgaard. (90) Vol. 59.
Description of an Apparatus for Interpreting Stability for the Use of Shipmasters.* Thomas Graham. (90) Vol. 59.
Further Experiments upon Wake anad Thrust Deduction.* W. J. Luke. (90) Vol. 59.
Marine Applications of Reduced Gears of Floating Frame Type.* John H. Macalpine. (90) Vol. 59; (58) Feb.
On a Method of Obtaining for Ship Design the Spacing of Bulkheads According to the Rules of the International Convention.* W. J. Lovett. (90) Vol. 59.
On Launching.* Percy A. Hillhouse and William H. Riddlesworth. (90) Vol. 59.
Some Experiments on the Influence of Running Balance of Propellers on the Vibration of Ships.* J. J. King-Salter. (90) Vol. 59.
Standardisation as Applied to the Machinery for Cargo Boats. D. B. Morison. (90) Vol. 59.
The Closing of Side Apertures in Ships from the Bridge.* E. Benvenuti. (90) Vol. 59.
The Design of Pin Joints Based on Ultimate Strength.* Walter A. Scoble. (90) Vol. 59.
An Analysis of the Principles of Industrial Management (Navy Yards). T. G. Roberts. (91) Vol. 25, 1917.
Application of Electricity to Various Auxiliaries on Shipboard. H. L. Hibbard. (91) Vol. 25, 1917.
Fabricated Ships. R. H. M. Robinson. (91) Vol. 25, 1917.
Power and Economy Test of the S. S. *Pontiac*. A. George Mattsson. (91) Vol. 25, 1917.
Recent Developments in Tank Steamer Construction. Robert W. Morrell. (91) Vol. 25, 1917.
Submarine Hulls. E. S. Land. (91) Vol. 25, 1917.
The Effect of Wind and Fouling Resistances on the U. S. S. *Neptune*. William W. Smith. (91) Vol. 25, 1917.
Gyro Ship Stabilizers in Service. Elmer A. Sperry. (91) Vol. 25, 1917.
Emergency Repairs to a Battleship. E. E. Wilson. (From United States Naval Institute *Proceedings*.) (11) Apr. 12.
Designing of Concrete Ships.* L. R. Ferguson. (Abstract of paper read before Am. Soc. of Marine Draftsmen.) (103) Apr. 27.
Concrete Ships: Why They Should be Built. E. O. Williams. (118) May.
Ljungström Turbo-Electric Ship-Propelling Machinery.* (11) Serial beginning May 3; (26) May 17.
Notes on the Operation of Submarine Diesel Engines. F. C. Sherman. (Abstract from *Journal* of the Am. Soc. of Naval Engrs.) (64) May 14.
Data as to the 5 000-Ton Concrete Ship, *Faith*, with Comment on its Costs. (86) May 22.
The History of Concrete Barge and Ship Construction. J. E. Freeman. (Abstract of paper read before Eng. Soc. of Buffalo.) (86) May 22.

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* Illustrated.

Marine—(Continued).

Tower Derricks Serve Twin Shipways at Submarine Boat Corporation Yard.* (13) June 6.
Werkspoor Marine Diesel Engines.* (11) Serial beginning June 7.
Federal Ships Erected by Derrick Travelers Built for Long Service.* (13) June 13.
Design Steel Ship for Maximum Efficiency of Bridge-Shop Fabrication. (13) July 4.
Government Designs and Builds 3 500-Ton Concrete Ships.* (13) July 4.
Construction Problems Many in Building Concrete Ships. (13) July 11.
Hog Island's Ship-Erection Equipment: Four Hundred Tower Derricks for Fifty Ways.* (13) July 11.
Machines for Making Wooden Ships.* (46) July 13.
Slag as an Aggregate for Concrete Ships.* Curtis C. Myers. (20) July 18.
La Construction des Sous-Marins. (Paper read before the Soc. of Naval Archts. and Marine Engrs.) (33) Mar. 9.
Données et Prévisions allemandes sur les résultats de la guerre sous-marine.* A. Goupil. (33) Mar. 23.
La Propulsion Electrique à Bord du Cuirassé Americain *Tennessee*.* (33) Apr. 13.

Mechanical.

An Aerial Tramway for the Saline Valley Salt Company, Inyo County, California. F. C. Carstarphen. (54) Vol. 81, 1917.
Notes on the Present Knowledge and Practice in Regard to the Briquetting of Iron Ores.* Guy Barrett and T. B. Rogerson. (71) Vol. 96.
The Failure of Boiler Plates in Service, and Investigations of the Stresses that Occur in Riveted Joints.* E. B. Wolff. (71) Vol. 96.
Deterioration of Refractory Materials.* H. B. Cronshaw. (71ª) Vol. 7.
The Failure of Short Tubular Struts of High-Tensile Steel (for Aeroplanes).* William Charles Popplewell. (63) Vol. 203, 1917.
Taylor's Pulp Sampler.* W. H. Trewartha-James. (74) Vol. 25.
A Comparison of the Working Costs of the Principal Prime Movers. Oswald Wans. (75) Oct., 1917.
Heat Engines.* H. Riall Sankey. (Thomas Hawksley Lecture.) (75) Nov., 1917.
A New Principle in the Flow of Heat. Carl Hering. (3) Jan.
America's Air Service.* W. F. Durand. (3) Jan.
The Design and Progress of the Floating-Frame Reduction Gear.* John H. Macalpine. (58) Feb.
Sulphated Tunnel Cement.* James Scott. (21) Mar.
A New British Oil Industry. E. H. Cunningham Craig and Others. (Abstract of paper read before Inst. of Petroleum Technologists.) (22) Mar. 1.
The Internal Combustion Engine. P. N. Everett. (Abstract of paper read before Assoc. of Eng. and Shipbuilding Draughtsmen.) (22) Mar. 1.
The Steam Turbine as Applied to Colliery Work.* P. J. Plevin. (Paper read before Assoc. of Min Elec. Engrs.) (22) Mar. 1.
Styles Three-Charge System the Highest Development in Public Utility Rate Making. (Applies to Gas Industry.) J. M. Spitzglass. (Abstract of paper read before Illinois Gas Assoc.) (24) Mar. 23.
How One Company Sizes Its By-Product Coke for Domestic Consumers.* Alan H. Harris, Jr. (Abstract of paper read before Illinois Gas Assoc.) (24) Mar. 30.
The Problem of Man-Power in Home Iron-Ore Supply Fields: Mechanical Appliances the Solution.* W. Barnes. (22) Apr. 5.
Coke as Blast-Furnace Fuel. G. W. Hewson. (Abstract of paper read before Soc. of Chemical Industry.) (22) Apr. 5.
A Survey of the Power By-Product Problem.* T. Roland Wollaston. (Abstract of paper read before Soc. of Engrs.) (22) Apr. 12; (57) Apr. 12.
An Extemporized Munition Factory.* (12) Serial beginning Apr. 12.
Further Notes on American Methods of Handling and Storing Iron Ore and Coal. (73) Apr. 12.
Some Physical Properties of Acid Refractory Materials and Methods for Estimating Them.* G. E. Foxwell. (22) Apr. 12.
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THE HELL GATE ARCH BRIDGE AND APPROACHES OF THE NEW YORK CONNECTING RAILROAD OVER THE EAST RIVER IN NEW YORK CITY

Discussion.*

By Messrs. Clement E. Chase and O. H. Ammann.†

Mr. Chase.

Clement E. Chase,‡ Jun. Am. Soc. C. E. (by letter).§—It is largely through innovations introduced into the design of large bridges, such as the Hell Gate Arch, that structural engineering advances. Precedents launched with such prestige may, in fact, become established in practice without being subjected to such critical examination of their merits as should be the case. An important new feature of the Hell Gate design, quite likely to be of wide influence, is the use of single, unusually heavy plates for the webs of the main chords.

Mr. Ammann states:

> "It is frequently maintained that better material is obtained in the thinner than in the thicker plates. This was not substantiated by the great number of specimen tests made for the Hell Gate Bridge from material varying from ½ in. to 2 in. in thickness. In general, the thick material showed as high elastic properties and ultimate strength as the thinner material rolled from the same heat."

From this the impression might be gathered that, in some unexplained way, the mills which produced the steel for the Hell Gate Arch had overcome the difficulties which had hitherto prevented the thickness of material being increased beyond average gauges (⅜ to ¾ in.) except at the expense of quality. This decrease in quality with

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* Discussion of the paper by O. H. Ammann, M. Am. Soc. C. E., continued from April, 1918, *Proceedings*.

† Author's closure.

‡ Poughkeepsie, N. Y.

§ Received by the Secretary, May 20th, 1918.

Mr. Chase. increase in thickness has not only been the commonly accepted belief of those whose experience has been greatest in testing steel, but there is on record ample experimental evidence to support this view, for example, Table 16 in the paper by Henry S. Prichard, M. Am. Soc. C. E., entitled "The Effects of Straining Structural Steel and Wrought Iron".*

It would seem that Mr. Ammann relies on the yield point and ultimate strength showing of the specimen tests (and these, presumably, the inspector's mill tests) to support the belief that the thick plates were obtained at no sacrifice of quality. However, neither of these values, as commercially determined, can be accepted as more than a fractional part of the measure of quality. For its complete determination, the actual elastic behavior, such as is presented to the eye in an accurate stress-strain curve, and the ductility, at least, must be known. Quality for structural uses should also take account—though possibly in lesser degree—of shock resistance and endurance under repeated loadings.

The increasing inferiority in ductility with increasing thickness is usually taken note of in specifications, to which the Hell Gate requirements (Table 1) are no exception.

There is no mystery in the inverse relation of thickness and quality of rolled steel; the necessities of commercial mill practice are sufficient explanation. Usually, plates or shapes of a wide range in weight per foot are rolled from ingots of the same cross-section, which causes the ratio of reduction to be less as the thickness of the product increases. Aside from this, the construction of the mills in use, which were designed almost without exception for lighter sections, demands that, when heavy products are being rolled, the steel must be finished hotter. Even if finished at the same temperature, a thick piece will cool more slowly than a thin one. The result, considered in terms of micro-structure, will be a coarser-grained material. It is well established that the larger the grain size of steel, the lower will be the stress at which deviation from elastic behavior occurs, the lower the elongation and reduction of area at rupture, the lower the shock resistance and the endurance under repeated loads.

The yield point and ultimate strength determinations of the mill tests, on which Mr. Ammann based his statement, have their usefulness in guarding against serious variations of a standard product from normal, but, as experimental proof of the adequacy of a new product for a new use, they would have but little weight. There are several reasons for this: they are made hurriedly, in commercial routine, which must disregard the niceties of testing; the samples selected are not representative of all parts of the material; and, as explained before, these characteristics are themselves a very incomplete statement of quality.

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* *Transactions*, Am. Soc. C. E., Vol. LXXX, p. 1541.

Mr. Chase.

Ordinary mill tensile tests are completed at a rate of from thirty to fifty per hour, and, even under the severest specifications in use, they are made much too quickly to have any scientific standing. It is not the writer's understanding that the Hell Gate specimens were tested with any refinements beyond those customary in inspecting material for other high-grade bridgework.

The misrepresentative character of mill tests is a matter of common knowledge. In comparing heats rolled into similar products, this may be overlooked, for the specimens are taken from the same locality in the product each time, and the tests are comparable, as far as they go. To judge of the full strength of the material over its entire cross-section, they would be inadequate. For instance, in the case of universal mill plate, tests are cut next to the rolled edge. By reason of the amount of work received, the lower working temperature, the radiation from three sides in cooling, and the distance from the more or less segregated axis of the plate, this part of the plate is ordinarily much superior to any other. It will show a higher elastic ratio and higher ductility than the center, and the thicker the plate the greater the difference between the showing of the edge and what would be the showing of the center. For sheared plate, the circumstances are much the same, except that the actual ragged edge is first removed by shearing.

That the yield point and ultimate strength (even if accurately determined and representative) do not alone tell the whole story of the structural usefulness of metal has, for columns, been strikingly pointed out in the recent final report of the Society's Special Committee on Steel Columns and Struts.

It is stated therein that:

"Neither the 'yield points' as indicated by the drop of the beam, nor the ultimate strengths, bear any consistent relation to the U. L. P.'s, or ultimate strengths, of the full-size columns."

The point to which is ascribed the greatest importance, the "Useful Limit Point", can only be located when the critical portion of the stress-strain curve is known with precision. Barring accidental blows, which would call ductility and shock resistance into play, or unlikely repetition of over-loads to the extent of testing repeated stress endurance, it is this curve which determines structural fitness. This is as true of tension members as of the compression members with which the report deals.

Bearing directly on the subject under discussion, the Committee finds that the useful limit of a column's unit strength decreases as

Mr. Chase. the thickness of the component material increases.* However, the Committee's tests did not include columns of equal cross-section, made up in the one case of single, thick plates, and in the other of several thinner plates, stitch-riveted together, and this leaves a loophole for arguments such as Mr. Ammann's on page 1690.† Referring to the Committee's test, he says:

> "If the heavy columns had been built up of several thin plates, tack-riveted together, their compressive strength would probably have been even less."

Although, possibly, some weakness is introduced in this way, the writer feels that it is of far smaller degree than the influence of thickness of material in reducing the limit of structural usefulness under load. It is rather strange that, with all the large-sized column tests which have recently been made, there should have been none to throw light on this point directly. The designers of the new Quebec Bridge evidently held one view, the designer of the Hell Gate Arch, the other; and yet only a few, relatively inexpensive tests would be required to settle the matter. The question is of fundamental importance, and should be removed from the field of speculation and controversy.

Mr. Ammann. O. H. AMMANN,‡ M. AM. SOC. C. E. (by letter).§—It is gratifying to note that the design of the Hell Gate Bridge structure as a whole as well as its general structural and architectural features are approved without exception by those who discussed this paper.

Some of the criticism on the general design of the Hell Gate Arch, the Little Hell Gate Bridge and on certain features of the approach viaducts has been answered by the designer himself, and it remains only to reply briefly to the discussion of various special features and details.

Selection of Type of Bridge.—Mr. Moisseiff is of the impression that the suspension type of bridge with a longer span would have been selected had the unfavorable foundation conditions on the Wards Island side been better known. As stated in the paper, the arch was selected in preference to the suspension type principally on account of the local conditions, which precluded long shore spans. Whether a suspension bridge with a shorter span would have been more economical under the soil conditions as actually found could be determined only by a complete design, but it is unquestionable that a suspension

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* The reader is referred to Tables 22 and 23 of the Final Report of the Special Committee on Steel Columns and Struts.

† *Proceedings*, Am. Soc. C. E., October, 1917.

‡ South Amboy, N. J.

§ Received by the Secretary, May 23d, 1918.

Mr. Ammann.

bridge with a longer span than the arch would have been more costly, in spite of cheaper foundations.

Had the unfavorable soil conditions been fully known earlier, a relocation of the line might have been closely investigated, but it is doubtful whether any saving could have been effected, because any other location would have meant a longer span.

Towers and Foundations.—The writer agrees with Mr. Moisseiff that towers are not an economical feature if intended for the exclusive purpose of keeping the resultant reaction within the middle third of the foundation area, because, if it is a mere question of sufficient weight of masonry, such weight can be provided more cheaply by extending the foundation in the direction of the axis of the bridge. Where it is a question of providing towers for architectural reasons, however, such towers constitute at the same time a considerable saving in the foundation masonry and are then not entirely for architectural purposes.

Bottom Chord Section.—Mr. Fowler comments on the section of the bottom chord as lacking in economy, when compared with the cellular circular type. This is true as far as economy of metal is concerned, but practical difficulties in making the circular section offset the economy. The form of section which Mr. Fowler proposes for the bottom chord of a cantilever bridge of 2 000-ft. span is an excellent substitute for the circular one, and would be particularly suited also for the main rib of a great arch. It is compact, and has no outstanding flanges or wide thin webs, which are always a source of local buckling; and the effective section is well distributed at equidistant points from the center of gravity. However, on account of its many pockets and oblique angles, which make fabrication expensive, it can hardly be recommended for sections of less than 1 000 sq. in. of effective area, especially when the chord is to be tapered, as was found desirable in the case of the bottom chord of the Hell Gate Bridge.

The Three-Faced Joint.—The comment on this joint of the bottom chord has been favorable. Mr. Moisseiff would deduct the excess stress, caused by the bearing over the middle third of the joint, from the specified unit stress for compression members. This does not appear to be necessary, and would offset the economy of the design. The bearing stress at the middle of the joint can reach the yield point without harm, as the metal thus strained is well confined on all sides within metal which is strained to less than the permissible limit, and to which it imparts its excess stress within a short distance of the joint. The three-faced joint approaches the condition of a roller, or ball bearing, for which the maximum bearing stress is

Mr. Ammann. allowed to run at least 50% higher than the average stress of a compression member.

Thick vs. Thin Plates.—One of the features most widely commented on is the extraordinary thickness of 2 in. adopted for the webs of the heavy compression chords. It is variously stated that experience has shown that thick metal is commonly not as strong and elastic as thin metal rolled from the same material.

The designer fully recognized this fact, and for this reason allowed a wider variation for the ultimate strength of hard steel, of which the 2-in. plates are made, than is allowed on ordinary structural steel (see foot-note below Table 1). It was expected that the thicker material would generally be below the "desired" strength or nearer the minimum, and the thinner one nearer the upper limit; also, a graduated lower limit was set for the elongation of thick material (see foot-note below Table 1).

The final specifications were drawn after thorough consultation with the manufacturers, whose obligation it was to produce, and who did produce, the desired qualities.

In spite of the expected slightly inferior physical qualities, the designer considered thick plates for compression members superior to thin plates, which are weakened by many stitch-rivets and the possibility of local buckling between the rivets.

The expectation of lower results for thick plates, however, was not borne out by the results. The individual test reports are not readily available at the present time, also space would not permit of their complete reproduction, but the fact is, as stated in the paper, that the tests of thick metal were generally as favorable as those of thin metal from the same heat. The only exception was the elongation, which ran slightly lower in the thick metal, but not to the extent allowed by the specifications.

The question as to the superiority of thick plates over stitch-riveted plates for compression members can be convincingly solved only by a series of systematic tests. In the absence of such tests, only judgment can govern; it would seem to the writer that it is sounder judgment to build up a member of solid metal unweakened by forceful injuries. Mr. Chase seems to take into consideration only the direct strains. How important the shearing stresses are in compression members is now well recognized with respect to the latticing of columns. That a lamellar bar is stronger in that respect than a solid bar does not seem plausible.

There is also a practical question to be considered. Rivets are apt to be less perfect the longer their grip and the greater the number of plates to be riveted together, and, therefore, it would seem that it is especially desirable to avoid riveting in large members, as far as possible.

Mr. Chase appears to assume that the writer disregarded the ductility of the steel, in comparing the test results of thin and thick metal. On the contrary, he took the elongation and reduction fully into consideration. These qualities in connection with the elastic limit and ultimate strength give the engineer a fair measure of the quality of the stress for practical purposes, without going into the theoretical niceties of stress-strain diagrams. Where the number of tests is as great as in the case of the Hell Gate Bridge, the fact that they are not made with extreme refinement has little bearing on the relative quality of thin and thick metal. Contrary to Mr. Chase's understanding, the tests were conducted with more than ordinary care and watchfulness on the part of the inspector. The testing machine was not allowed to run with a greater speed than 2 in. per min., and the objectionable features of commercial mill testing, as mentioned by Mr. Chase, were avoided. More specimens were made from each heat than in ordinary practice, and the specimens were cut both parallel and at right angles to the direction of rolling, and from both the edge and center of the plate.

The writer cannot see what shock resistance and endurance under repeated loads have to do with the question under consideration.

Assembling of Trusses.—In reply to Mr. Wagner's inquiry, relative to the assembling of the arch trusses, the writer wishes to state that the specifications prescribed complete assembling of the truss. On request, the Bridge Company was subsequently allowed to assemble each section of four panels, the last panel being reassembled to the next section, thus insuring accuracy for all connections.

Floor Construction.—The writer cannot agree with Mr. Wagner that the floor construction would have been made more durable by waterproofing, by which presumably is meant a water-proof covering of the concrete. The cost of a good water-proof covering is out of proportion to the advantage gained, but even the best water-proofing known cannot be as durable as the concrete base itself. If it becomes defective, it is likely to cause more trouble than if it had not been used. In the case of the Hell Gate Bridge and approaches, the concrete slab has been made water-proof by carefully selecting the materials and determining the proper proportion to secure the greatest density, by carefully troweling the surface to a smooth finish before the concrete had set, by using sufficient steel reinforcement to prevent cracking, and by giving the surface sufficient slope and providing frequent and large drain holes to give the water a free run-off.

Mr. Ammann.

In concluding, the writer heartily thanks all who have taken the pains to discuss this paper for their courteous expressions of approval of the manner in which this rather complex subject has been presented. He earnestly hopes that the discussion on some of the disputed questions may be an inducement for further investigation.

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PAPERS AND DISCUSSIONS

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STRESS MEASUREMENTS ON THE HELL GATE ARCH BRIDGE

Discussion.*

By Messrs. C. A. Randorf, David A. Molitor, and D. B. Steinman.†

Mr. Randorf.

C. A. Randorf,‡ M. Am. Soc. C. E. (by letter).§—Few engineers have had the experience or the opportunity of conducting tests of the importance and magnitude of those described in this paper; therefore, few can speak with authority on the subject.

In reviewing the results obtained by the author, the writer has been impressed with regard to two points which seem to be most important, namely, the accuracy of the measuring instrument, and the accuracy or rather inaccuracies due to the possible varying ductility of the steel in the bridge.

In the writer's opinion, a micrometer such as the Howard strain gauge is well adapted to work of this kind, due mainly to the simplicity of the instrument, which minimizes the effect of the personal equation. The writer realizes that the observer must exercise extreme care in taking the readings, and must have had experience in operating the instrument, but, with well-trained men as observers, the probable error due to the instrument and its operation, will be less than the actual fluctuating results due to the varying qualities in the steel.

The stress measurements, however, are based on the assumption that the modulus of elasticity for the steel used in this bridge is 30 000 000; undoubtedly, this value is more or less variable, although it is accepted as a constant term in formulas where the elasticity of the material is concerned; but, when stresses are computed from actual strain measurements, the modulus of elasticity of the material should

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* Discussion of the paper by D. B. Steinman, M. Am. Soc. C. E., continued from April, 1918, *Proceedings*.

† Author's closure.

‡ Buffalo, N. Y.

§ Received by the Secretary, April 22d, 1918.

Mr. Randorf be verified by special tests, if possible, in order to ascertain its extreme variations. It is evident that this cannot be done after the structure to be tested has been erected; but it can be done when the regular tests are being made in the laboratory.

The writer refers to the paper by O. H. Ammann, M. Am. Soc. C. E., giving an account of the design and construction of Hell Gate Bridge,* in which is given a résumé of the chemical analysis of the steel used, indicating a variation in the carbon of from 0.27 to 0.34 per cent. This would have a direct bearing on the ratio of the unit elongation or strain to the unit stress, in other words, the modulus of elasticity.

A certain amount of variation or segregation of the carbon will occur in the best commercial steels. Manufacturers have adopted methods to eliminate as far as possible the unequal distribution of carbon and other impurities, but the art of making steel has not as yet become perfect.

With these facts in mind, however, it would seem reasonable to assume that the author did arrive at quite accurate results, inasmuch as the data are based on the averages of a great many extensometer readings.

The writer believes that the data offered in this paper are of inestimable value to the Engineering Profession and well worth careful study by all engineers interested in bridge construction.

Mr. Molitor. DAVID A. MOLITOR,† M. AM. SOC. C. E. (by letter).‡—The results of stress measurements presented in this paper certainly merit the highest appreciation from the Engineering Profession. Special thanks are due to Gustav Lindenthal, M. Am. Soc. C. E., for his keen forethought and insistence on proving the correctness of the theoretic stress computations in this monumental structure.

These stress measurements undoubtedly possess great scientific value, and, from the engineering viewpoint, it would seem that their main purpose should consist in substantiating the correctness of modern methods of stress analysis, regardless of whether these are simple or complex, so long as the results of stress computations can be accepted as sufficiently reliable to warrant their adoption as the basis for safe designs. In the event that stress measurements could be shown to invalidate the results obtained from modern methods of analysis, the dictates of conscience should prompt us to search farther for truths not yet discovered.

The author, on page 1812,§ states: "The final object of the extensometer measurements was to provide a comparison between the calculated and the actual secondary stresses in the structure." He then mentions the peculiarities in the design and methods of erection and riveting, concluding with the statement: "These features, separately and combined, modify the secondary stresses materially, and render it extremely difficult, if not impossible, to arrive at the true secondary stresses by calculation".

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* *Proceedings*, Am. Soc. C. E., October, 1917, p. 1651.

† Detroit, Mich.

‡ Received by the Secretary, May 10th, 1918.

§ *Proceedings*, Am. Soc. C. E., October, 1917.

The writer did not find any reference in the paper which would explain how any of these features, especially the three-faced butt-joints, were considered in the secondary stress computations; yet on this point hinges the whole question of how close an agreement could be expected between actual and computed secondary stresses.

These features, as described by the author, and applied to a bridge of this type (two- or three-hinged braced arch), would necessarily result in very small secondary stresses. Therefore, it is most gratifying to know that the good judgment of the designer was verified by the stress measurements which gave secondary stresses averaging about two-thirds of those computed. However, the 50% excess of the computed over the measured secondary stresses may have been due to the manner of computation, if the three-faced butt-joints were not properly considered.

In order to prove or disprove the correctness of the more accurate methods of secondary stress computations, a more suitable structure would have been a simple truss with subdivided panels, wherein the secondary stresses usually attain high values. If the computed values were found to be in close agreement with the measured stresses for such a structure, a fact which is only partly substantiated at present, it would be safe to conclude that the methods are reliable for bridges of all types. To draw such a conclusion from the facts presented in the paper, however, is unwarranted, and is apt to minimize the importance of the question of secondary stresses in ordinary bridges.

The author, on page 1828,* in attempting to establish conclusions for guidance in specifying extreme working stresses for bridge members, offers a suggestion which no doubt would meet with great favor among those who are willing to take a chance on the "factor of ignorance" rather than familiarize themselves with modern methods, which are often avoided on the pretext that they are too complicated and laborious. The author states "that a rule of this form can properly apply only to structures in which the secondary stresses have normal or average values", but fails to give any criterion by which to recognize such structures; neither does he convey any good idea of what constitutes a normal value.

The writer's practice is to ascertain the maximum total stress due to dead-live-impact loads, plus secondary stress and temperature effect,

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* *Proceedings*, Am. Soc. C. E., October, 1917.

Mr. litor. if any, and then design the member for the allowable unit-stress. By making proper allowances for live-load stress reversals, he aims to produce a design of uniform strength throughout, for 100% over-load in live plus impact loads, without exceeding the elastic limit.

The ordinary method of analysis, used by the author, involving the solution of a series of simultaneous equations equal in number to the total number of panel points in the span, for each case of loading, is admittedly laborious, and might have been somewhat simplified.

By referring to any treatise on secondary stresses, it is apparent that the theoretic analysis of the problem is quite simple, although the numerical work is laborious, on account of the solution of the final set of simultaneous equations, and, as stated by the author, "the expediting of the entire computation depends largely on the method selected for solving these equations". The method of Gauss is often used to obtain a direct algebraic solution, though many simplifications have been suggested to minimize the labor involved by this method. The method of successive approximations, used by the author, has some merit, though much labor is still required, especially when the process is carried to the third approximate values.

In view of these facts, it would appear that a method of computing secondary stresses which avoids the laborious solution of a set of simultaneous equations would commend itself to bridge specialists and students of this subject.

Such a method has been given, in the chapter on secondary stresses, in a treatise* by the writer, but seems to have entirely escaped the attention of the author as well as others who have dealt with this subject.

It would be transgressing the rules of the Society to quote this analysis here, and as it is treated very exhaustively and illustrated by a complete problem, the reader is referred to the original text. A very much simplified method of solving symmetric equations—known in mathematics as equations of Clapeyron—is also given on page 294 of this treatise, where the solution was effected with a 10-in. slide-rule. This method was also applied by the writer in solving normal equations, up to fourteen in number, and with the same slide-rule, as early as 1907; hence, the discovery by Mr. José Páez, announced by Professor Jacoby in his discussion of this paper, was antedated by at least 5 years, and possibly by more than 40 years, as Mohr's work equations, when applied to many redundants, become identical with normal equations.

The agreement between the calculated and measured values of the secondary stresses in the Hell Gate Arch does not appear to be very satisfactory, from a scientific standpoint, though the disparity is not serious, because these stresses are never excessive in a bridge of this

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* "Kinetic Theory of Engineering Structures", Chapter XIII, 1911.

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type, especially when extraordinary conditions are introduced for the express purpose of reducing them still further. The author, on page 1830,* evaluates the relation between the measured and calculated secondary stresses in the form of an approximate empiric statement according to which the percentage of measured stress equals half the percentage of the calculated stress, plus 15, and adds that the factor, ½, would probably have a higher value in other structures. Accordingly, one or the other value, attributed to the secondary stress in any member, must be radically wrong. That is to say, either the computed secondary stresses are much too high, owing to some error in theory or its application to the three-faced butt-joints, or else the measured stresses are too low, for some reasons not discernible from the data presented.

On Plate XXXIX, the extreme fiber distance for the lower chord is given as 63.6 in. for Member 0-2, with diminishing values to 41.9 in. at Point 22. These are in accordance with Fig. 4, without any allowance for the three-faced joints, and, if these distances were used in computing the fiber stresses from the bending moments, Navier's law has been violated, and the resulting stresses may easily be 50% too high for practically all cases of loading, except the maximum dead-live-impact load, for which no stress measurements were made.

On the other hand, the location of the extensometer points adjacent to the ends of a member may, or may not, give maximum fiber stresses; and as there is only one point at each end of each member for which the fiber stress can be a maximum, there is great likelihood of missing this point in locating the points for measurements, and hence the chances for obtaining consistently low measured fiber stresses are very great. For the direct stresses, this danger is not encountered.

The fundamental equations for computing secondary stresses are expressions representing the relations between the unit direct stresses and the angle distortions resulting from these stresses, for every triangle of the frame. The angle distortions are thus derived on the assumption of frictionless pin connections between all members. These angle distortions, thus found, are then assumed to represent the bending effects in the members which are prevented from taking place by virtue of rigid riveted connections at the ends or joints. Hence, as the material, even at the joints, is elastic, and not rigid, some elastic distortion will take place in the apex angles of every triangle, the extent of which will depend on the quantity of metal and riveting used in the connecting plates, and, whatever this may be, its amount will be lost in the production of bending stresses in the members themselves. For very stiff joints, or heavy details, this will be a small quantity, representing an error on the side of safety in computing the secondary stresses. Therefore, the computed secondary stresses must always be slightly in excess of the actual values, but the error is relatively small and not in a class with the findings recorded in the paper.

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* *Proceedings*, Am. Soc. C. E., October, 1917.

The actual maximum bending stress could hardly occur at the extreme end of a member, but would be developed at some distance back, near the edge of the connecting plate, and that point would have to be located very accurately in order that the measured fiber stresses may be accepted as a true measure of the maximum bending stress. This, again, does not apply in the same way to the direct stress.

Hence, it is quite evident that some disparity will always exist between computed and measured secondary stresses, without casting any serious reflection on the accuracy of either value, unless the doubt can be located definitely.

In conclusion, the writer expresses his sincere appreciation of the author's contribution to this subject, and trusts that the remarks presented herewith may be accepted in the sense of constructive criticism.

D. B. Steinman,[*] M. Am. Soc. C. E. (by letter).[†]—The writer wishes to take this opportunity of acknowledging his cordial appreciation of the courtesy and interest of all those who have discussed his paper. The number, range, and significance of the discussions have been greater than were anticipated for a subject in so new a field, and the interest evinced by so many high authorities in the Profession has been gratifying.

In eliciting this series of valued contributions of data and thought to the science of structural stresses, the writer feels that his labors in conducting the investigations under consideration, and in analyzing and reporting them, have found their full justification and reward.

The various discussions will be taken up in the order in which they were received by the writer.

Mr. Powell, in commenting (page 2499)[‡] on the precision of the extensometer measurements, reports that he has found it difficult in his experience with gauges to take readings correct to a tenth of a thousandth of an inch.

The writer does not claim that this degree of precision was secured, nor does he wish to minimize the difficulty of even approximating it. Throughout the work, a number of readings were taken for each gauge measurement until the results appeared to be consistent within two or three ten-thousandths of an inch, and then the average of the last three or four readings was recorded. The proof of the accuracy secured by this procedure, using the instrument and method of manipulation described in the paper, does not lie in abstract considerations, but in the actual comparison of measurements at the two ends of

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[*] New York City.

[†] Received by the Secretary, May 6th, 1918.

[‡] *Proceedings*, Am. Soc. C. E., December, 1917.

Mr. Steinman.

each member, or of observations made on the same gauge points on different days.

Mr. Powell regards as objectionable features the conical measuring points of the extensometer and the conical holes for the insertion of these points. It is true that these would give rise to error if the instrument were not held square to the holes, but this is a precaution which is easily observed; moreover, as pointed out by Professor MacKay (page 534*), a slight deviation from the perpendicular produces an entirely negligible error.

The question of getting a satisfactory micrometer "feel" with conical points bearing against the inclined sides of the holes, and of the difficulty of securing a thorough cleaning out of the holes, are also raised by Mr. Powell; but these and other difficulties were fully recognized by the writer and his assistants, and necessitated extreme care in every phase of the work. It may be stated that the cleaning of the holes before each measurement usually consumed more time than the actual taking of the readings; but, with conscientious and practised observers, using every possible precaution, the effects of the above-mentioned difficulties were minimized, and reliable measurements were secured.

If any more accurate instrument were known, or any better method of preparing and taking care of the gauge points, the writer would have been glad to adopt it for the Hell Gate Arch observations. The suggestion made by Mr. Powell to use slightly projecting ball-ended cylindrical studs, instead of the conical holes, with an ordinary micrometer replacing the Howard instrument, is certainly worth trying; but it appears doubtful whether it would yield sufficient increase in accuracy to justify the greater labor required in preparing the gauge points. Moreover, as Mr. Howard suggests (page 2508),† the use of drilled holes better enables the gauge lengths to be preserved and protected.

The writer is grateful to Dr. Waddell for his kind remarks on the value and importance of the measurements; and heartily endorses his recommendation that the experiments on the Hell Gate Arch should be completed, so as to include the effects of live loads.

Mr. Frankland suggests an interesting programme of stress investigations, to embrace measurements on the Quebec and the Sciotoville Bridges, and the completion of the tests on the Hell Gate Arch. The undertaking of this work by the American Society of Civil Engineers, under the supervision of a special committee, would certainly extend our knowledge of stress conditions, and develop improvements in both design and construction.

Professor Waterbury proposes an interesting theory to account for the anomalous results found by the writer in some of the members of

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* *Proceedings*, Am. Soc. C. E., March, 1918.

† *Proceedings*, Am. Soc. C. E., December, 1917.

Mr. Steinman.

the final stage, where the upper end uniformly presented a larger average stress than the lower end. Professor Waterbury's explanation of the possible influence of the order in which the drift-pins may have been replaced by rivets is very lucid, and is one of the theories which the writer had in mind when he wrote:

> "This anomalous result appears to arise from some unexplained disturbance of stress distribution, and does not represent any error of observation."

If Professor Waterbury's theory is correct, there still remains to be explained why the effect described was confined to the members near the end of the span, and why the larger resulting stress was invariably found at the upper end in each of these members.

The point brought out by Professor Waterbury, that the correct average stress at a cross-section can be obtained only by weighting each stress reading in proportion to the area of metal it represents was recognized by the writer in his early studies. At one time, as a result of a comparison of the respective areas represented by the middle and the corner gauge points, the rule was tried of giving the middle readings twice the weight; but this did not yield as consistent results as the method which was finally adopted of simply averaging the six readings at each cross-section.

Mr. Hughes submits a comparison of the two extremes which h has observed in bridge design practice, *viz.*, excessive and sometime meaningless precision in computation of stresses and in proportionin of members, on the one hand, as contrasted with slipshod and skimp detailing of members, in violation of the fundamental principles o safety, on the other. No one will take exception to the recommendatio that the most acceptable practice lies between these two extremes.

When Mr. Hughes advises the measurement of stresses on all struc tures in which there may be uncertainty of condition as a result o erection operations or eccentric loading, he is recommending somethin highly desirable but probably impracticable. The work of taking stres readings is expensive, and requires carefully selected and well-traine observers.

The writer is indebted to Dr. Fuller for his able and comprehensiv discussion, and regards the latter's close study of the paper and h careful scrutiny of the results and conclusions as a high complimen This contribution eminently succeeds in the object suggested in i opening paragraphs as a guiding purpose for such discussions, name to "throw even greater light on the subject, and to remove the la shadow of doubt in regard to the interpretation that may be drawn."

Dr. Fuller refers to the writer's statement that measured seconda stresses will usually be lower than computed ones. The only exceptio

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to this rule arise when there are special circumstances in the fabrication or erection of the structure which tend to increase the secondary stresses in a manner not provided for in the computations. An example of such augmentative factor, in the case of the Hell Gate Bridge, was the cantilever method of erection; this unavoidably gave rise to large secondary stresses, which persisted after the structure passed from the cantilever to the three-hinged condition. There was no way of computing the effect of this transition in advance of actual test, consequently the secondary stresses in Stage 3-*H* exceeded the calculated values. This fact was frankly displayed in Table 5 and in the graph on Fig. 5, and the explanation was suggested in the text.

Consequently, when Dr. Fuller points out that wherever the primary stresses exceeded 3 000 lb. per sq. in. the measured secondaries were greater than the computed values, he is not upsetting the writer's conclusions in this regard; he is focussing attention on what is merely an example of the qualifying circumstances outlined in the foregoing paragraph; for it happens that all stresses exceeding 3 000 lb. per sq. in. occurred in Stages 3-*H* and 2-*H*; and in these stages the special conditions just described came into play.

In the more common methods of truss erection, there is no abrupt transition from one structural form to another, like that involved in the cantilever erection of the arch; consequently, in such cases, there will be nothing to invalidate the correctness of the calculation of secondary stresses. This may be regarded as the normal or usual condition obtaining; the final stages of the Hell Gate Arch erection represent an unusual or exceptional condition. With these considerations, the writer does not see any reason for renouncing his belief that the measured secondaries will normally be smaller than the calculated values.

The fact that this relation was fulfilled by the measurements taken in all the eleven erection stages preceding the closure of the arch, and that the exceptions are found only in Stages 3-*H* and 2-*H*, would seem to be a convincing corroboration of the writer's thesis.

If there were a satisfactory method of providing in the computations for the complicating effect of the transformation from cantilever to arch, and for any similar cause of augmented secondary stresses, then there would be no need of appending any qualification to the writer's conclusion as to the relative values of measured and calculated secondaries.

As a consequence of the above-described effect of the cantilever method of erection, the final stresses in the extreme fibers of the Hell Gate Arch chord members would have been seriously larger than the computed values, were it not for the provision of the three-faced joints; and this measure would have been of little value without the additional

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precaution which was adopted, of postponing the riveting until after the arch was closed.

If the joints had been riveted as the erection proceeded, instead of waiting for the closure of the span, it would have been possible to calculate the secondary stresses more definitely; the complicating effect of the transformation from cantilever to arch would have been obviated, and the final measured secondaries, in all probability, would not have exceeded the computed values. The only question is whether these advantages would have outweighed those which were secured by the use of the three-faced joints in conjunction with deferred riveting.

In connection with the points just discussed, Dr. Fuller asks for the results of the measurements of secondary stresses in Stage 3-*H*, and the writer is glad to supply these values in Table 9.

TABLE 9.—Stage 3-*H*.

(All values are in pounds per square inch.)

Member.	Calculated S. S.	Measured S. S.	Member.	Calculated S. S.	Measured S. S.	Member.	Calculated S. S.	Measured S. S.
0-2	104	238	8-10	264	1 125	16-18	710	994
2-0	445	813	10-8	395	925	18-16	897	844
2-4	319	388	10-12	425	688	18-20	1 079	1 050
4-2	104	738	12-10	565	738	20-18	959	1 182
4-6	8	788	12-14	613	513	20-22	1 124	1 482
6-4	324	1 013	14-12	728	1 013	22-20	935	750
6-8	328	463	14-16	752	1 200	22-22 A	1 187	900
8-6	200	713	16-14	660	850	22A-22	258	563
Average							557	832

The averages shown at the foot of Table 9 are the values which were included in Table 5. It should be noted that the measured secondary stresses in Stage 3-*H* averaged 50% higher than the calculated values, as a consequence of the conditions discussed in the preceding paragraphs.

The erratic character of the individual results in this stage is to be attributed to the fact that the calculated and measured values do not refer to identical conditions of the structure. The calculated secondaries were obtained for the completed stage, with the entire floor erected, whereas the measured values were secured during early and varying stages of the floor erection. In consequence of the rapid progress made in this erection stage, as compared with the slow operation of taking the observations, the different measurements were obtained ith changing positions of the erecting travelers and with varying ıantities of floor system completed. Without the excessive labor of ımputing secondary stresses for so many different conditions of dead ad on the structure, a proper comparison of calculated and measured ılues could not be submitted; for this reason, these percentages were nitted from the tabulation on Plate XXXVI. Mr. Steinman.

Dr. Fuller calls attention to the low percentages of computed secıdary stress tabulated on Plate XXXIX as contrasted with the higher ılues of the measured secondaries in the same stage (2-*H*) given on late XXXVI. There really was no need of going to two different ates to find this relation, as it is frankly exhibited in direct comparins in Plate XXXVI. It is also indicated by the upper branch of the aph of measured secondaries on Fig. 5. It should be remembered. wever, that these values of the measured stresses correspond to the sual theoretical definition of secondaries, as one-half the difference tween the top and bottom fiber stresses; whereas, in this instance, on count of the effect of the three-faced joints, a more suitable definition the secondaries is the excess of extreme fiber stress over the average ress in the section.

Ordinarily, these two definitions of secondary stress are equivalent; the Hell Gate Arch chord members, however, the distinction is imrtant, and it is evident that the second definition is the one of greater actical significance. In Fig. 5, the two methods of defining the meased secondaries are represented by the two branches of the graph for tage 2-*H*; the divergence of these two branches shows the benefit cured by the use of three-faced joints, namely, to reduce the meased secondaries from an average of 220% down to an average of 58% the calculated values.

The question is raised by Dr. Fuller as to the possibility of variation stresses within the 20-in. gauge length that was used, and he sugsts that smaller lengths are needed to catch the maximum values. his may be the case in short-span reinforced concrete beams and slabs, here, on account of the rapid drop in maximum stresses from the ints of connection of members, it is found desirable even to reduce e customary 8-in. gauge length to 2 in. In the case of the 45-ft. embers of the Hell Gate Arch, however, the variation of stress in a -in. length, at the points where the measurements were taken, was actically negligible, and the use of a shorter instrument would offer advantage to compensate for the reduced accuracy of the results.

Investigators whose experience in strain measurements has been on ncrete structures should remember that, on account of the difference elastic coefficients, extensometer observations on steel require about teen times as great accuracy in order to secure the same precision in e values of the stresses; consequently, a longer gauge line is necessary work on steel structures. Furthermore, in reinforced concrete spans,

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the flexural stress declines rapidly, along a parabolic curve, from th end connection to the point of contraflexure; whereas, in steel chor members, the secondary stress has a linear variation which is ver gradual in comparison.

For the Hell Gate Arch investigations, both 10-in. and 20-in. exter someters had been provided; but the considerations just outline prompted the writer to adopt the 20-in. instrument for the measur ments on the main members, and to reserve the 10-in. instruments f observations on gusset-plates and on other connection details. It regretted, however, that lack of time made it impossible to go very f with the latter measurements, or to take any observations on the di tribution of stress between plates and angles composing a section.

The suggestion is made by Dr. Fuller that a Berry instrume might have given more satisfactory results than the Howard stra gauge, but he confesses that he has never used the latter. In the D partment of Bridges, of New York City, the Howard instrument w adopted for all stress investigations, after consideration and trial other types. With the Howard strain gauge, accurate results a secured by repeating the readings until they prove consistent and th recording the average. Although the Berry extensometer may perm quicker readings, it is doubtful whether the same accuracy is afford as a larger number of moving parts are involved. The Berry gau gives all desired accuracy for getting stresses in concrete, on accou of the lower value of the modulus of elasticity; and it has its advanta of speed for observations under changing load; but, for the work whi was done on the Hell Gate Arch, it is believed that the Howard gau was the more suitable.

Mr. Howard mentions some of the interesting possibilities of mea urements with his extensometer, and he certainly merits the than of the Profession for his invention of the instrument and for developi its application. It is to be regretted that he has never found ti to prepare, for the Society, an account of his measurements alo the different lines to which they have been applied.

The writer communicated with Mr. Howard in reference to seve points raised in these discussions and received the following lett in reply:

"INTERSTATE COMMERCE COMMISSION
"DIVISION OF SAFETY
"WASHINGTON
"MAY 11TH, 1918.

"DR. D. B. STEINMAN,
"35 Nassau Street,
"New York.

"DEAR DOCTOR: Please excuse this tardy response to your letter the 7th inst. I have been out of town part of the time.

"In regard to Mr. Powell's misgivings that the use of the stra gauge does not permit the necessary accuracy, I might mention th

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o far as check readings go they very often come out better than night be expected. Some readings taken on the lower chord of the Missouri River bridge at Kansas City in the forenoon and repeated n the afternoon of the same day chanced to accord to the same en-thousandth throughout the series, of some twenty or more readngs, corrections for temperature made in each case. The drilled and eamed holes in the bridge member are however rarely so well made hat readings can be repeated as above. Usually the readings on the eference bar check, without variation greater than one-thousandth. The degree of accuracy depends upon the care exercised in drilling nd reaming the holes. The holes should be smoothed with a conical et after drilling and reaming. A series of readings where successive hanges in the loads occur very generally yield results which indicate he readings are reliable to one or two ten-thousandths. I do not nake use of readings down to a ten-thousandth but place reliance pon the stresses to less than 500 lbs. per sq. in. If there was any eed of greater refinement in the work I think it could be had by xercising more care. Differences in temperature limit the degree f accuracy in many cases. My impression is that the gauge readings re better than I claim for them. If Mr. Powell's experience is with late gauges or with plug or ring gauges and he finds it difficult to ttain an accuracy of a ten-thousandth of an inch then his aptness or fine measurements is not to be commended. No good machinist vould think he had a satisfactory fit if it was not within a tenhousandth of an inch on fine work. Sensitiveness of touch, in some laces, is such that measuring to a ten-thousandth can be considered s more than ordinary work.

"In respect to holding the gauge in position normal to the work. Provided the drilled and reamed holes are strictly normal to the lane of the work, I do not think a slight inclination of the gauge vould be found to give a change in the reading. The conical points f the gauge would make contact very nearly as a cylinder and center hemselves on an elliptical contact zone. Reference lengths in the ield are not paralleled as a rule and normal to the surface of the vork. In order to avoid error in placing the gauge, it is my practice o use the same end of the gauge over the same hole in each observaion, and judge of the gauge being normal to the work by noting the nnular space around the conical point at the same end of the instrunent on each occasion. One person should hold the instrument in lace against the work, another advance the micrometer and make ontact, and read the gauge. With suitable conditions, the holes being n good order, there is hardly any trouble in noting contact by sensiiveness of touch, with an accuracy of one ten-thousandth. Mr. Powell's suggestion of using a projecting pin with spherical end is not a practical one. Without going into the reasons why, if Mr. Powell will try such a method he will at once see the many difficulties which will defeat the accuracy easily attained with conical points and drilled and reamed holes. I doubt whether he would offer such a suggestion if he ever had experience with his suggested method. Of course the holes have to be cleaned at each reading. Dust has measurable thickness or diameter and must not be included with the steel member.

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"In regard to Dr. Fuller's remarks about the use of a Berry gaug which has a bell crank lever in its construction, strictly considere this is not a satisfactory detail of design. There is a difference betwee tilting a gauge of my type in which both points remain in the sam plane and the action of a bell crank contact at one end. The rect linear movement of the inner member in my gauge is mathematicall correct. With this rectilinear movement there is no reasonable lim to the range of the instrument. I use a micrometer screw of one-ha inch travel. It could be used with an inch travel or more if desire The action of the gauge would not be impaired if the gauge lengt on the work was an inch longer or shorter than the reference ba You will readily see how limited the use of a bell crank lever is i such an instrument as a strain gauge. The readings might be repeate and check in each case and still the measured length be in erro Parallel and rectilinear movements are desirable in instruments c precision.

"I note your kind allusion to the desirability of hearing from me i some of the strain gauge work not yet published, and much regret th I have not done so. Perhaps at an early date I may have opportunit to prepare some notes on the Missouri River Bridge and som structural work done in New York.

"Yours very truly,

"(Signed) James E. Howard."

Dr. Lindenthal explains the considerations which prompted him t undertake the measurement of the stresses in the Hell Gate Arch. I a review of the erection of the Eads' Bridge at St. Louis he present a striking illustration of the possible serious effect of stresse created in a bridge during construction, and he thus emphasizes th importance of ascertaining the actual stresses left in a bridge afte erection. He succinctly expresses the guiding consideration in hi concluding paragraph:

"The object of the strain measurements, as related by the autho was fully attained. There are no unknown stresses in the Hell Gat Arch structure."

Dr. Lindenthal certainly deserves all possible credit for his initia tive and public spirit in personally defraying the expenses of thi investigation as a contribution to engineering science.

Mr. Delson presents an account of a very interesting series o extensometer observations conducted by the New York Department o Bridges in connection with one of the operations of strengthening th side spans of the Williamsburg Bridge. This experience of the Bridg Department afforded a striking instance of the value of the extenso meter in such work, as the measurements supplied the informatio necessary for the solution of a perplexing and critical erection problem

The stress readings presented by Mr. Delson in connection with thi incident also indicate the high precision attainable with the Howard extensometer.

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Professor Parcel, in a very able discussion, raises some doubts as to the validity of two conclusions which he credits to the writer. The first of these conclusions is stated as follows:

"1.—Actual secondary stresses, in general, will be less than the computed stresses, due largely to a constant automatic re-adjustment of the internal strains tending toward the relief of secondary stresses."

This is a correct and clearly expressed paraphrase of statements made in the paper, but the writer wishes to make it clear that he did not offer this principle as a direct conclusion from the results of the investigation under discussion. It was merely an expression of a relation which he derived from outside considerations, and in the validity of which he had, and still has, firm conviction. It was interjected as a partial explanation of certain findings, and not as a direct deduction from the data of this experiment.

Professor Parcel admits that the principle is perhaps entirely sound, but he questions its consistency with the results of the measurements. On this point the writer has already presented his case in replying to the discussion of Dr. Fuller. For the sake of clearness, even at the risk of reiteration, it may be stated here that all apparent violations of the above-formulated relation in the comparison of the final results were associated with the unique and exceptional features in the Hell Gate Arch erection—features that do not occur in the usual cases of truss building. The most significant of these special features was the cantilever erection, resulting in the fixation of large secondary stresses at the joints during the cantilever stages, which stresses were not released in the transformation to the arch condition.

The special erection feature just described would naturally affect the results in Stages 3-*H* and 2-*H*, tending to increase the secondary stresses in those stages above the calculated values. This is exactly the phenomenon observed, for it is only in those stages that the measured secondaries exceed the calculated; and this fact, to which both Professors Fuller and Parcel call attention, instead of contradicting the writer's conclusions, serves as a clear confirmation of the correctness of his reasoning.

Apparently ignoring the above considerations, Professor Parcel thinks that the following additional conclusion might fairly be drawn: "For the higher ranges of primary stress, the actual secondary stresses will probably exceed the calculated values by a considerable margin." To this conclusion the writer takes distinct exception. It is based on a comparison of the results in the arch stages with those in the cantilever stages—a comparison which yields misleading conclusions, or conclusions the generality of which is vitiated, on account of the

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The writer maintains that the apparent exception in Stages 3-*II* and 2-*II* to his rule, that actual secondary stresses will generally be less than computed stresses, is due merely to the fact that in these stages there was a gross but unavoidable incorrectness in the calculated secondaries. He regrets the inadequacy of the available methods of computing secondary stresses to take into account the effect of such complicating factors as the transformation of the structure from a cantilever into an arch. If a satisfactory solution of this mathematical problem were obtainable, there is little doubt that the anomalous results under discussion would be entirely dispelled.

It may be suggested here that the problem just described would be simple of solution if the joints were securely riveted before the transformation. It is the partial and unknown slipping or yielding of the joints before or during riveting that complicates the theoretical problem.

The second conclusion presented by Professor Parcel for discussion is:

"2.—For most bridges it will probably be satisfactory to provide for secondary stresses by an allowance in the specified unit stresses of about 20% of the total primary stress, plus 3 000 lb."

A comparison of this version with that of the writer in Conclusion 4 on page 1836* will indicate certain differences. The writer did not suggest the deduction of 25% plus 4 000 lb. from the elastic limit as a "satisfactory" allowance but as a minimum "necessary" allowance. In doing this he was merely calling attention to the necessity, in fixing extreme values of working stresses, of leaving a sufficient margin below the elastic limit to provide for secondaries and other anticipated additions to calculated primary stresses; and he wished to suggest the possible usefulness of investigations of this character in supplying information to help fix the proper magnitude of this margin or allowance. The value suggested by the writer was simply the best one that he could deduce with the aid of the data of this experiment; and it was offered for whatever it was worth, merely as an initial contribution to the fund of knowledge requisite to form a proper judgment on this point. No one realizes better than the writer the importance of securing similar data from measurements on a great number and variety of structures before any final decision on such a question can be reached.

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The writer's reasons for including this matter in the paper were twofold: First, to indicate an additional objective for extensometer and secondary stress investigations; and, second, to suggest a form for an empirical rule for a margin above extreme working stresses.

In the original presentation of this tentative rule, on page 1828,* it will be observed that judgment based on outside considerations generously supplemented logical deduction in the formulation of the conclusion. It was more in the nature of a suggested line of thought and future investigation than a final and direct conclusion from the data of the investigation.

That the limitations and present indefiniteness of such an empirical rule were clearly realized by the writer is shown by the following quotation from the paper:

> "It is recognized, of course, that a rule of this form can properly apply only to structures in which the secondary stresses have normal or average values. Where unusually large secondaries may be anticipated, these should receive special investigation and attention."

Professor Parcel raises the question "whether any empirical relation based on averages is an adequate means of providing for secondary stresses, even in ordinary structures." The writer endeavored to make his proposed allowance sufficiently generous to take care of the maximum, and not the average, secondary stresses ordinarily occurring. That the suggested allowance is adequate is corroborated by the results of Professor Parcel's own measurements of secondary stresses as plotted in Figs. 9, 10, and 11. These graphs show that the secondary stresses in a railway bridge under service loading ranged between 10 and 30%, and never exceeded the latter amount except when the primary stresses fell very low; and, as Professor Parcel himself remarks, "it is only the secondary stresses that co-exist with the maximum primary stresses that affect the design of the structure."

The writer does not take issue with Professor Parcel's suggestion of the desirability of making some analysis of the secondary stresses in every design of a bridge structure. That, indeed, would be a most desirable consummation; but it is going to be very difficult to convert the Profession to such procedure in the case of ordinary structures, or to get clients to pay for the additional labor involved.

In proposing the use of empirical allowances for secondary stresses, the writer was not actuated by any distrust of the reliability of secondary stress computations, nor by any doubt as to their desirability, but rather by a conviction of the difficulty of changing present practice in this regard. So long as engineers have to deal with actual conditions where secondary stress computations are generally omitted, it is certainly better to have some guide for estimating a proper allowance than to get along without any. Therefore the writer offered, as a

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suggestion, a rule for this purpose, derived from his best judgment, guided by the results of this investigation. No data tending to contradict or modify this rule have yet been advanced.

Professor Parcel writes:

> "If we assume that theoretical computations for secondaries are wholly untrustworthy, and thus justify reliance on an empirical formula for ordinary bridges, how are we to rely on our analysis for the cases where 'exceptionally large secondaries may be anticipated', and what basis is there for the elaborate and very expensive correction methods used in the erection of the Quebec and Sciotoville spans, methods which have been referred to in current technical literature as the most remarkable single feature of these great engineering projects?"

In reply the writer wishes to make it clear that he does not regard theoretical computations for secondaries as untrustworthy; on the contrary, he is convinced that, with the exception of cases involving complicated erection features, which cannot be accurately considered in the computations, the actual secondaries will be either equal to or slightly less than the calculated values. The use of an empirical formula is recommended, not as being more reliable than theoretical computations of secondary stresses, but as constituting a more or less satisfactory substitute when time and labor have to be conserved.

Referring to cases where "exceptionally large secondaries may be anticipated", the writer submits that such cases can readily be recognized by any one who has had proper experience in the study of secondary stresses. Exceptional stresses will be found at points where there is any interference with the production of a smooth curve of deformation of a span or of a single member. Such points are: at the feet of main hangers in simple Pratt trusses; at the feet of sub-hangers in trusses with subdivided panels; at the connections of collision struts; at the points of attachment of back-stays in cantilever erection of arches; at intermediate supports of continuous and cantilever bridges; at the connections of intersecting diagonals, etc. Fortunately, in nearly all such cases, it is possible to ascertain the approximate value of the critical secondaries by some simplified method based on local deflections without undertaking a complete theoretical analysis of the secondary stresses in the entire structure. It would seem that such procedure, in combination with the use of an empirical rule for the secondaries of ordinary magnitude in the structure, would provide a safe and economical solution of the problem of providing for secondary stresses.

Professor Parcel refers to the elaborate and expensive erection methods which were adopted for the elimination of the secondary stresses in recently completed long-span bridges. In the case of the Sciotoville Bridge, the writer can speak from experience, as he was

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identified with the design and computations for that structure. The Sciotoville Bridge presents a striking instance of a case where "exceptionally large secondaries may be anticipated." Over the middle support of this continuous structure, there is necessarily a large upward cusp in the curve of deflections, and the secondary stresses from this cause, for live load on both spans, would have amounted to nearly 20 000 lb. per sq. in. Although elaborate secondary stress computations were prepared for the entire structure, the critical stress just mentioned was easily foreseen; and it was computed in a few minutes from the deflection diagram of the trusses, quite independently of the more complete analysis of secondaries. Similarly, the secondary stresses in the bottom chords at the connections of the various subhangers could have been foreseen and computed independently by approximate methods. Such approximate investigations would have been sufficient to disclose the serious character of the secondary stresses in this structure, and to emphasize the necessity of some such method of erection as was adopted to counteract these dangerous stresses.

Professor Parcel adds:

> "We need a great many more experimental data to settle the question of actual *versus* calculated secondary stresses, no doubt; but the bulk of the evidence, up to the present, would seem to justify considerable confidence in our theory."

It is difficult to understand what is referred to in the phrase "the bulk of the evidence, up to the present"; since, as the writer endeavored to point out in the introductory part of the paper, there had been practically nothing published in the form of a comparison of calculated and measured secondary stresses before the presentation of this investigation. Nevertheless, the writer joins Professor Parcel in placing considerable confidence in the theory of secondary stresses; in fact, it does not appear that any one has questioned it.

The results of stress measurements on the Kenova Bridge, presented by Professor Parcel, are certainly interesting. It is unfortunate that the data have not yet been worked up to show a comparison between measured and computed secondaries, and it is to be hoped that this analysis will soon be completed and presented to the Profession.

The writer is grateful to Professor MacKay for directing attention to a point of possible misunderstanding, namely, the statement in the paper about the number of measurements required to determine the distribution of stress in any member. When he wrote "It is necessary to take measurements at not less than three, and preferably four, points of the cross-section near each end of the member", the writer intended this merely as a statement of minimum requirement, to apply only to members of ordinary size and section; and he is in complete accord with Professor MacKay in considering that a greater number of points are usually desirable in large members. The writer

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recognized this fact in the case of the Hell Gate chord members, of which he wrote (page 1817*) that "measurements at the four extreme corners of the section would not be fairly representative of the conditions throughout the entire area."

The figures cited by Professor MacKay from the Hell Gate measurements to show that the omission of the readings near the center of the webs would have altered the results, serve as a confirmation of the writer's judgment in deciding to use six observations at each cross-section. The two readings at mid-height were necessary, not only on account of the mass of metal concentrated at and near the middle diaphragm, but also to determine and provide for the effect of the concentration of bearing in the middle thirds of the joints.

Whether a larger number than six observations at each section should have been taken, it is difficult to decide. It is doubtful whether there would have been any appreciable increase in the reliability of the results to compensate for the curtailment of programme which the extra labor would have necessitated.

The data of tests on latticed members submitted by Professor MacKay are extremely interesting. His plats of stress distribution near the end of a pin-connected member show a concentration of stress toward the center of the web, as might be anticipated. He also shows the disturbance of uniform stress condition at the points of connection of diaphragms and lattice bars, on account of local bending in the ribs composing the member. It was in anticipation of such effects that the writer avoided the proximity of diaphragms, splice-plates, and similar factors of stress disturbance, in fixing the locations of the gauge points for his stress measurements on the Hell Gate Arch.

In correspondence with the writer, Professor MacKay described some of his measurements on bridges of the Canadian Government Railways, and it is to be regretted that these came too late to be included in his published discussion. With Professor MacKay's permission, the following is quoted from one of his letters:

> "My work on the C. G. R. bridges was limited to a single type of riveted pony truss span, and my object was to check primary, secondary, and impact stresses under live load. The results would dispose me to endorse all of your conclusions applicable to such widely divergent cases, with the possible exception of the point referred to in my discussion."

The following are some of the results as regards precision in the span most thoroughly examined. The range of stress measured was from 5 000 to 8 000 lb. per sq. in.

Difference between calculated and observed primary stresses:

Average..................	390 lb. per sq. in.	(525)
Maximum................	780 " " " "	(1 290)

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This omits some lower chord members which were affected by stringer and floor-beam action, and by the failure of roller bearings to work.

Difference between stresses in two ends of same member:

Average	270 lb. per sq. in.	(140)
Average, omitting one section	160 " " " "	
Maximum	960 " " " "	(500)
Maximum, omitting one section	320 " " " "	

Most of the work was done under favorable temperature conditions.

As regards secondary stresses, the most important effects agreed fairly well with calculated stresses.

The figures in parentheses, representing corresponding values from the Hell Gate Arch investigation, have been inserted by the writer to permit a comparison with the results secured by Professor MacKay. When the difference in the characters of the structures and loadings is considered, the two sets of results may be regarded as mutually confirmatory.

In the discussion by Professor Turneaure, we have a clear presentation of the significance of secondary stresses by one who is an acknowledged authority on the subject. He writes that he "does not believe that it will ever be necessary or desirable to calculate secondary stresses in the ordinary practice of bridge design; but he does believe that their consideration, both theoretically and experimentally, in such unusual structures as the one under consideration, is of very great importance."

It was in connection with the ordinary cases of bridge design, for which no calculation of secondary stresses is undertaken, that the writer suggested the use of an empirical correction to be applied to the working stress. Referring to the suggested figure of 25% + 4 000, Professor Turneaure agrees that this "would probably cover most cases of well-designed structures." In arriving at this estimate of a proper deduction from the minimum elastic limit, the writer took into consideration, not only the secondary stresses usually to be expected, but also other possible variations from computed stress.

The writer, as previously stated, did not intend to present the foregoing recommendation as a direct and rigorous conclusion from the results of the calculations and measurements on the Hell Gate Arch. Other considerations entered in arriving at this figure, and it was offered merely as a guide or basis for future investigation and discussion. Consequently, the following statement by Professor Turneaure on the possible value of the suggestion is appreciated:

> "If it is found that the secondary stresses in any particular structure can be represented safely by a particular percentage of the primary stresses or a percentage plus a constant, then we have arrived at a

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fair value of the maximum fiber stress, and are much better prepared to discuss the subject of working stresses than if no estimate of the secondary stresses had been made."

In reference to the reliability of secondary stress calculations, Professor Turneaure writes:

"Such stresses are just as much a real part of the total stress which may prevail in any fiber of a member as the primary stress; and they are just as certain to exist as it is certain that the structure will deflect under load. The accuracy of their determination, however, is not so great as that of the primary stresses, on account of the indeterminate effect of the temperature variations and of joint plates, rivets, and other details."

It is on account of this uncertainty which characterizes secondary stress calculations that the writer recommends the application of the extensometer to the actual determination of the fiber stresses in all structures of unusual magnitude or construction.

Referring to the great care taken in the design and erection of the Hell Gate Arch and of other large structures as evidence of the increasing appreciation of scientific methods of design and accurate fabrication, Professor Turneaure writes:

"Where such conditions prevail, the objection to the use of statically indeterminate structures, which has been so general in the past, loses its force, and there would seem to be no reason for excluding such forms of structure where, for other reasons, they are desirable."

This statement cannot be too heartily endorsed; it expresses what is probably the most important lesson to be learned by the Profession from the work on such structures as the Hell Gate Arch and the Sciotoville Bridge.

Professor Jacoby emphasizes the value of scientific investigation as conducive to security and economy in structural design. He adds:

"When observations are made on an actual structure, especially one in which the members are so large and where the resources of construction in equipment and workmanship are taxed to a much higher degree than usual, the results are of far greater value than laboratory experiments could possibly give."

The realization of this opportunity in connection with the erection of the Hell Gate Arch was the incentive for undertaking the stress measurements, and the justification of the financial outlay on the part of Dr. Lindenthal.

The summary of the investigation of secondary stresses in a two-hinged, spandrel-braced arch with cantilever arms, computed by Mr. Thomson Mao, of the Cornell University Graduate School, and presented by Professor Jacoby, constitutes a valuable contribution to this discussion. It exemplifies the diversity of methods applicable

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to the calculation of secondary stresses. In Mr. Mao's thesis, Mohr's method was used, involving the use of displacement diagrams to find the change in slope of the truss members. The method of Winkler, in which angle changes are found analytically, is preferred by the writer, because of its greater precision and ease of checking.

Another distinctive feature in the method of computation followed by Mr. Mao was the calculation of the secondary stresses in all the members of the structure for a unit load at each of the panel points. Except for spans having a very small number of panels this procedure would involve too great an expenditure of time and effort for application in actual practice. All essential purposes of secondary stress computations will be served if the analysis is made for a much smaller number of cases of loading. As a rule, the simplest considerations of the natural deflection characteristics of a structure will indicate the proper loading assumptions for maximum secondary stresses; and an inspection of the load lengths for maximum primary stresses will indicate the one or two loading assumptions which will give, with sufficient accuracy, the critical secondary stresses, namely, those occurring simultaneously with the maximum primary stresses.

Relative to this matter, the writer would offer, as a recommendation for future secondary stress computations, the suggestion to compute the stresses for just two load conditions, *viz.*, the first and the second quarters of the span, respectively, loaded. By simple reversal of the diagram and algebraic addition of the sets of stresses, there will be obtained the secondary stresses for load covering one-quarter, one-half, three-quarters, or full span, or any other combination of quarters of the span. The resulting values will suffice for all practical purposes, and by this procedure the analysis will involve only two solutions of secondary stresses, instead of the ten or more required in Mr. Mao's work.

Professor Jacoby recommends the method of Gauss for the solution of the sets of simultaneous equations involved in the computations. He writes:

> "By the method of Gauss, the solution of the equations becomes quite mechanical, and may be checked at every step of the process. This method of solution, therefore, has a great advantage over any other."

The writer doubts whether this method can compare favorably in speed with the procedure of successive substitution, as described on page 1838,* which was used for the Hell Gate computations, and yielded a remarkable showing over all other methods in its greater speed and self-checking advantages.

On this point, the writer has had some correspondence with Professor Turneaure, who advocated an improved method of successive elimination as being the most expeditious. To this the writer replied:

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"I believe that if you include the time required to check the work, to locate errors and to rectify them, the method of elimination will be seriously handicapped in comparison with the methods of successive approximation by substitution. The figures which I gave you in my last letter for the time required by the different methods included the work of retracing the steps whenever an error was suspected, and of correcting any such error. If we consider the primary desideratum to be correctness of the results, rather than merely securing of maximum speed, it seems to me that the method of substitution is the more desirable, as it supplies an automatic check at every step in the work. It is a self-checking method in that it is impossible to proceed very far without detecting any error that may have been made."

The writer has worked out a systematic arrangement of the computations in the method of successive substitutions so as to minimize the consumption of time and the possibility of mistakes. In actual test he has not yet found any other method to equal it in the desiderata of speed and self-checking.

The writer is grateful to Mr. Ammann for calling attention to the possible danger of applying the conclusions of this paper without due regard to special conditions which might modify the results.

In discussing the findings of his investigation, the writer has been careful to keep in mind at all times the special features in the design and erection of the Hell Gate Arch which would affect the results in any way. He submits that a careful perusal of the ten conclusions presented at the end of the paper (pages 1835 to 1837*), will show no violation of this principle.

There is but one paragraph occurring in those pages, which is not a rigorous deduction from the results of the investigation; but its very form indicates that it was not presented as a deduction or conclusion, but rather as a parenthetical adduction of a conviction entertained by the writer and tending to throw light on certain results obtained. It refers to the observed fact that most of the measured secondary stresses during the erection of the arch were less than the calculated values, and reads as follows:

"It is believed that similar results, though not as marked, would be found in other structures. The actual secondary stresses will generally be lower than the calculated values. There is an automatic re-adjustment of strains within a structure in such direction as to relieve the secondary stresses."

The writer trusts that no one will take exception to the foregoing statement, as it is a simple matter to demonstrate, both mathematically and practically, the validity of the proposition therein enunciated. It is not a conclusion from the present investigation, although it is corroborated by the results obtained.

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* *Proceedings*, Am. Soc. C. E., October, 1917.

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Apart from this passage, which was not intended as a conclusion, and from Conclusion No. 4, which has already been the subject of extensive discussion, the writer would like to ask Mr. Ammann to point out anything in the summary of conclusions which can possibly be regarded as too far-reaching a deduction from the results of the investigation.

Mr. Ammann refers to the objects for which the measurements were undertaken, but this matter has already been presented in the paper and in Dr. Lindenthal's discussion.

Mr. Ammann points out that one of the objects in the programme of investigation has not been accomplished, namely the measurement of the live-load stresses in the finished structure. It is to be regretted that Dr. Lindenthal interrupted the investigation at this critical point, and the writer joins Mr. Ammann and the others who have expressed the hope that some Federal bureau or technical society may take up the measurements, so as to include the final live-load stresses.

Mr. Randorf contributes an important suggestion as to the possible influence of the varying elasticity of the steel on the results of the measurements. Although a uniform value of 30 000 000 for the modulus of elasticity was assumed in reducing the observations, the effect of possible variation from this value was discussed on page 1826* of the paper.

Professor MacKay, in his investigation, as mentioned on page 532,† adopted a value of 29 000 000 for the elastic modulus. The difference in the quality of the steel in the two structures tested would justify this difference in the assumed values of E.

Mr. Randorf's suggestion that the modulus of elasticity of the material should be verified by special tests is certainly a good one. In the present case, the satisfactory agreement between average calculated and average measured stresses would appear to be a confirmation of the correctness of the assumed value of E; nevertheless, it is readily conceivable that some of the variations in the results might be traced to fluctuations in the elasticity of the material.

Most of the questions raised in Mr. Molitor's valued contribution have already been answered in connection with the preceding discussions. There are a number of points, however, which call for individual consideration.

Referring to the features which gave rise to the observed discrepancies between calculated and measured secondary stresses, Mr. Molitor wants to know why these features were not provided for in the computations, so that a closer comparison might have been secured.

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* *Proceedings,* Am. Soc. C. E., October, 1917.

† *Proceedings,* Am. Soc. C. E., March, 1918.

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Perhaps the best way of answering this question is to present for individual consideration the following list of factors tending to produce deviations from computed secondary stresses:

1.—The common theory of secondary stresses assumes absolute angular rigidity of the connections, whereas, actually, there must be some elastic yielding or mechanical slip between the members. This condition, occurring to some extent in all structures, tends to relieve the secondary stresses. The amount, however, is unknown, and is not susceptible of analytical determination. The effect is augmented materially by the slip and re-adjustment which take place when the drift-pins and bolts used temporarily during erection are replaced by rivets. No attempt is made to correct for this condition in the computations, as the part due to elastic strain is too small to justify the effort, and that due to mechanical slip is too erratic and arbitrary to permit analysis. It is, of course, on the safe side to ignore this effect.

2.—The common theory of secondary stresses neglects the bending moments produced in the members by the eccentricities resulting from their flexural deformations. This condition tends to augment the secondary stresses in compression members and to reduce them in tension members. Provision for this effect greatly complicates the analysis and computations, and ordinarily it may be disregarded. For long and slender members, however, the effect would be appreciable.

3.—In the generally accepted method of analyzing trusses, the primary stresses are determined on the basis of frictionless joints. There is a small error involved in this assumption, as the joints are not frictionless, but possess rigidity. The elastic curvature assumed by the members under the secondary strains gives them a girder action whereby a certain amount of transverse shear is transmitted from panel point to panel point, and the primary stresses are relieved to that extent. This, in turn, results in a slight modification of the secondary stresses, generally a reduction; but the effect is small, and as the corresponding calculations are laborious, they are neglected.

4.—Shop inaccuracies in laying out the rivet holes for end connections, either as to distance or angle, will produce secondary stresses not covered by the computations.

5.—Temperature differences between parts of the structure or of the same members will produce secondary stresses not included in the calculations.

6.—Inaccurate facing of the ends of compression members may produce eccentric bearing at the butt-joints, and the effect will appear in the measured secondary stresses.

7.—An important factor is the use of drift-pins during erection. When these are replaced by rivets, a certain amount of mechanical slip and re-adjustment of strain occurs at the joints, permitting a

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partial release of the secondary strains. If the secondary stresses then obtaining are contrary in sign to the final secondaries at the same points, the ultimate effect of the mechanical slip will be an augmentation of secondary stress. On the whole, this feature is too erratic and arbitrary to permit analysis; consequently, it is not provided for in the computations.

8.—For large, built-up sections, there is some uncertainty as to the distribution of stress over the cross-section. Navier's law cannot be assumed to apply with positiveness. The division of stress between the plates and angles composing the section may be imperfect, depending on the riveting; and local stress concentrations are produced by splices, diaphragms, and details. All these conditions affect the measured secondary stresses, but cannot be provided for in the computed secondaries.

The foregoing list of disturbing factors should serve to make clear why the exact values of the secondary stresses cannot be anticipated by computation, and why the results of theory should be supplemented by experimental investigations aiming to throw light on the individual and collective amounts of these deviations from the calculated stresses.

In addition to the conditions previously outlined, which are of more or less general occurrence, there were, in the case of the Hell Gate Arch, two other features affecting the secondary stresses, as follows:

1.—The three-faced joints: With regard to these, it is important for clearness to distinguish between their action in relieving the primary stresses in the outer fibers, and their influence in permitting partial hinge action at the connections during erection. The former effect does not change the secondary stresses (defined as one-half the difference between top and bottom fiber stresses); consequently, no correction for it is necessary before comparing measured and calculated secondaries. The hinge effect, on the other hand, does modify the secondary stresses, but it is more or less indeterminate qualitatively as well as quantitatively. It is resisted to an unknown extent by the presence of the splice-plates and drift-pins; and it ceases to occur when the primary stresses attain an undefined value. The ultimate effect on the secondaries will depend on the reversals of secondary flexure taking place during erection. For these reasons it would be practically futile to endeavor to provide for this hinge action in the computations.

2.—The cantilever erection: This produced large secondary stresses during the erection stage, and a part of these persisted in the structure after its transformation into an arch.

The effects of the ten features just enumerated as influencing the secondary stresses are complicated by their action in combination. The action of the three-faced joints is modified by the interference

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of splice-plates and drift-pins; the effect of the cantilever erection is controlled by the unknown amount of hinge action taking place as a result of the three-faced joints; the replacement of drift-pins by rivets is accompanied by an uncertain amount of slip and strain redistribution in the connections; and the transformation from cantilever to arch involves unknown re-adjustments of strain at all the joints.

In his computation of the secondary stresses, the writer followed the established procedure and did not provide for the previously discussed modifying factors. To take all these features into account analytically would be impossible; for most of them even a qualitative prediction would be difficult. The best that can be done is to determine their combined effect experimentally for individual cases, until sufficient data are thus accumulated to form a basis for empirical rules to be applied to other structures.

Mr. Molitor suggests that the features just discussed would necessarily result in very small secondary stresses. If he had predicted, in advance of this investigation, that the combined effect of these features would be to reduce the secondary stresses, he would have proved himself a poor prophet; for, as it happens, the secondary stresses in the final stage average about 120% greater than the corresponding computed values. (See Table 5.) He would have been underestimating the intensifying effect of the cantilever method of erection, which, in this case, outweighed the combined influence of all the other features tending to modify the secondary stresses.

What Mr. Molitor apparently has in mind is the easily anticipated relief in the stresses in the outer fibers as a result of the greater concentration of pressure in the middle thirds of the three-faced joints. This, however, is not a secondary stress in the accepted sense of the term; it is merely a redistribution of the primary or axial stress over the cross-section. In the case of the Hell Gate chord members, this action of the three-faced joints proved to be a saving feature; it just about neutralized the resultant augmentative effect of all the other disturbing conditions, so that the final extreme fiber stresses came down to the calculated values (see page 1833*). For the sake of clearness, however, it should be understood that this effect of the three-faced joints, although representing a reduction of the outer fiber stresses, is not, strictly speaking, a reduction of the secondary (or flexural) stresses. It does not affect the comparison between measured and calculated stresses so long as these are defined as one-half the difference between top and bottom fiber stresses.

No exception can be taken to the point made by Mr. Molitor that the Hell Gate Arch Bridge is not the most suitable structure for proving or disproving the correctness of secondary stress computations; but that was not the object of these investigations. The

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* *Proceedings,* Am. Soc. C. E., October, 1917.

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measurements were undertaken primarily for the purpose of ascertaining the actual stresses in the Hell Gate Arch, and that object was attained. Incidentally, the results secured have been studied and the conclusions reported in order to throw whatever light they can on the effects of the various features tending to modify the stresses.

In this connection, the writer wishes to point out that, although the Hell Gate Arch results represent the composite effect of many stress-modifying elements, nevertheless, the measurements may be studied so as to single out the effects of some of the special features. For example, by comparing the results in the arch stages (3-*H* and 2-*H*) with those in the preceding cantilever stages, information is secured on the effect of the transformation from cantilever to arch; and it is thus found that this single feature of the erection outweighs the combined effect of all the other factors modifying the secondary stresses. Similarly, a comparison of the final secondary stresses according to the respective definitions represented by the two branches of the graph in Fig. 5, yields directly the effect of the three-faced joints in relieving the outer fiber stresses. With these two special features (cantilever erection and three-faced joints) separated out, there is little left in the results and conclusions that may not be of general application to other structures.

Referring to the method used for computing the secondary stresses in the Hell Gate Arch, Mr. Molitor remarks that it is "admittedly laborious, and might have been somewhat simplified". If Mr. Molitor knows of any solution that is less laborious, or of any further simplification that might be introduced, the Profession would certainly welcome his contribution. If, however, he is referring to the method described in the chapter on Secondary Stresses in his book, he is claiming an advantage which is not substantiated by actual comparisons. That solution was invented and published by Müller-Breslau more than 30 years ago, but it has failed to stand the test of time in competition with other methods.

The writer uses Winkler's method which involves only one unknown for each panel point, whereas Müller-Breslau's treatment requires the solution of two unknowns for each member. Thus, for the Pratt truss worked out by Mr. Molitor in his book, he has to determine 22 unknowns; for the same problem, Winkler's method would involve only 6 unknowns. The simultaneous equations in Winkler's solution are one for each panel point, while Müller-Breslau's method requires in addition three equations for each truss triangle; and the method of elimination used for solving these equations is no more expeditious than the procedure of successive approximations used by the writer.

In the discussions there has been practically no mention of two of the most interesting facts established in the course of the investigation.

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One was the hinge action of the three-faced joints, permitting, in the early stages, a certain amount of rotation which was easily measured. The other was the re-adjustment and re-distribution of stress at the joints when the drift-pins were replaced by rivets. Before the measurements were made, doubt was expressed in certain quarters as to the actuality of both of these anticipated effects, but the investigation has set all such doubts at rest.

In conclusion, the writer wishes to repeat his acknowledgment of indebtedness to all those who have discussed the paper, as he realizes that their contributions have greatly enhanced its usefulness to the Profession. On account of the necessary brevity of the paper, some of the thoughts and conclusions were perforce inadequately presented; and the discussions so generously contributed have helped to focus attention on the points of greatest interest and to remove any doubts as to the interpretations to be drawn.

This paper would not be complete without a closing tribute to Dr. Lindenthal for his foresight in conceiving the investigation, and for his public spirit in undertaking it at his own expense.

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PAPERS AND DISCUSSIONS

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ICE DIVERSION, HYDRAULIC MODELS, AND HYDRAULIC SIMILARITY

Discussion.*

By Messrs. E. E. R. Tratman and Benjamin F. Groat.†

Mr. Tratman. E. E. R. Tratman,‡ Assoc. M. Am. Soc. C. E. (by letter).§—Reference to the model of Capt. Meigs' elevated railway, in Mr. Fletcher's discussion,‖ suggests the further information that a full-size section of this railway structure was built and operated with a locomotive and car. This was done for purposes of demonstration, and on the occasion of a visit by the writer, in 1894, Capt. Meigs had the engine fired up and the train operated. The length of the line was about 1 114 ft., with curves of from 50 to 120 ft. radius, and grades up to 345 ft. per mile.

Mr. Groat. Benjamin F. Groat,¶ M. Am. Soc. C. E. (by letter).**—It was hoped there would be more discussion of the ice diversion works proposed by the writer. There will be more to say about actual examples in the future. Most of the criticisms relate to imaginary difficulties which it is feared will arise by reason of gravel and silt filling the diversion channels. The best answer to this is that the writer has already constructed several ice diversion channels, and there is no indication of their filling for many years, if ever. If they do partly fill, they can be dredged out at very little expense.

When ice jams are prevented by transportivity control, it will be of positive advantage to have the channels between the transverse ridges fill with detritus, and the designer should aim to direct the higher transporting velocities over the channels in order to accom-

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* Discussion of the paper by Benjamin F. Groat, M. Am. Soc. C. E., continued from March, 1918, *Proceedings*.

† Author's closure.

‡ Wheaton, Ill.

§ Received by the Secretary, April 17th, 1918.

‖ *Proceedings*, Am. Soc. C. E., March, 1918, p. 497.

¶ Pittsburgh, Pa.

** Received by the Secretary, May 15th, 1918.

Mr. Groat. plish this result. In such cases the transverse channels will have been left empty simply to save the expense of filling them.

No comprehending designer would plan channels causing velocities capable of throwing detritus into an intake. Bottom transporting capacity can be controlled, as well as transportivity. The proper design first separates and preserves the lower currents of water, containing depositable material, from the upper currents of surface water and floatage, after which the latter are diverted down stream with the lower currents of detritus.

The successful operation of ice-diversion works depends not alone on channels, but also on an intelligent general planning and location of the structures.

Mr. Parker's discussion is valuable and welcome. No doubt it is difficult to deal with mountain torrents, and the question of detritus and submerged timber is serious at times, even on the larger rivers of low velocity. In the latter case it is known that bad winters frequently bring to certain plants damage amounting to several hundred thousand dollars, due to such causes. If the racks are taken out, stones get into the turbines; if the racks are kept in place, they plug with ice and cause a shut-down.

The writer is certain that rack spacing has been generally too small, and that, with the rapidly increasing sizes of turbines, there should be a commensurate increase in size of rack openings, the design of which should take into account very carefully the sizes and character of timber and floatage actually occurring in the feed water.

Records should be kept at the power-house to determine these questions, and thus there may be designed a more appropriate screen. Records of this kind are not usually available before the power-house is built. Racks are not the only element of a power-house which may need to be reconstructed after the plant has been in operation for a time.

The writer is now designing a screen for a large power-house on the principle that it should be a unit distinct from the power-house, rather than be apportioned in individual screens among the turbine units. The advantage of this is that, if a portion of the screen is plugged, it will not be necessary to shut down any turbine, as, by the plan mentioned, water from any part of the screen will feed to any and all wheels. Moreover, individual screens are illogical when considered financially. The investor is not only compelled to pay a large sum to secure a sufficient cross-section for a water passage in concrete leading to a turbine, but is also compelled partly to fill it again with an expensive steel obstruction throughout the section. In many situations, as Mr. Parker suggests, racks may be omitted, at least for part of the year.

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Mr. Parker closes by asking the question:

"Is it not reasonable to regard a deflecting diaphragm, as shown here, with a subsurface intake entry, as promising better results under all conditions, and more logical to adopt, than the usual rack so easily clogged either by trash or ice?"

The writer replies to this by saying that he prefers not to capture gravel, but rather to divert it in the manner indicated in the paper; that he is well acquainted with several deflecting diaphragms, like Mr. Parker's in principle, and that, so far as diverting ice is concerned, they can be considered as nothing short of colossal failures—colossal because of their excessive cost.

The writer does not doubt that such a diaphragm might operate successfully in deep water when the draft is relatively small, but prefers the open intake, with sub-surface diversion channels and ridges to throw the ice away from the intake and divert it down the main channel. In the case of intakes, much more than with screens, the investor pays a large sum to secure a sufficient waterway to his power-house, and then engineers proceed to fill it with expensive concrete piers, steel frames, racks, and perhaps diaphragms, the latter taking up more cross-sectional area that could otherwise be made available than all the rest of the redundant structures referred to. A diaphragm cannot produce a real sub-surface diversion.

The writer thinks that the gravel trap under the diaphragm, as described by Mr. Parker, is unnecessary. Its action cannot depend on the heavy longitudinal fall given its bottom, but only on the slope of the water surface along the streamward face of the diaphragm. At least, this must be so when there is much depth of water in the pond. Thus, the rush of water out of the gravel trap through the wooden gate would be confined to the lower end of the sluice, thereby allowing gravel to accumulate at the middle and upper end.

It would be better to eliminate the sluice, and provide a complementary diaphragm immediately under the upper one and extending upward from the stream bed sufficiently to cut off the flow of gravel to the opening between the two diaphragms, depending on the current of the stream, aided by the wooden gate when necessary, to wash the gravel down stream. The writer once actually secured a small supply of water free from floatage and detritus by just such a contrivance.

Professor Fletcher makes the mistake of considering the immensity of the consequences of an ice jam after it has formed. These are the things which ice diversion ridges and channels will prevent, not by taking up an ice jam bodily and shaking it to pieces, but by preventing the accumulation of the pieces.

Mr. Groat. Ice jams can surely be prevented by transportivity control at critical places, in such streams as the Niagara and St. Lawrence, when the necessary expenditures can be justified.

The photographs of the model (Figs. 8 and 9) illustrate the effects of transportivity control in a situation different from that represented by the model shown by Figs. 1 to 6. If the transverse ridges were carried entirely across the main stream, and were properly designed, they would prevent an ice jam in that location, supposing jams to be likely to occur there.

Models.—The nature of the discussion discloses the main facts which the paper intended to emphasize, namely, that the possibilities in ice diversion and in designing by using hydraulic models are not fully appreciated by engineers generally, and that such demonstrations as the paper affords are imperatively needed.

This is illustrated forcibly by Mr. Leighton's quotations and remarks which are closed by him as follows:

> "As it would be difficult, if not impossible, to copy such conditions on a model scale, it occurs to the writer that the first section of Mr. Groat's paper furnishes an excellent illustration of the probable fallacies in the last section."

Professor Fletcher closes his remarks by saying:

> "When we consider the demonstrated fact that the transporting power of a stream varies as the sixth power of the velocity; that the energy of the flowing water varies as the cube of velocity; and know that, by geometrical necessity, any model on a reduced scale lacks weight and stability in itself to test its full capacity, under diminutive conditions, we are obliged to object to the quoted all-inclusive claim for the validity of model studies and experiment, especially where hydro-dynamic operations are involved."

In fundamental contrast with such ideas, there are the valuable results of actual experiments with models as used by Mr. Smith in designing the spillway and channel of the Boonton Dam. It is to be hoped that Mr. Smith will soon publish the results of the model tests which he is now conducting relative to the plans for the Schoharie development of the Catskill water system, and, later, the results of observations on the actual structure for comparison.

Mr. Hunt's suggestion during the oral discussion is also quite enlightening; that is, a model is the only means for reproducing all the complexities of flow caused by natural channel conditions. The writer replied to this by saying that there were other methods, but now wishes to qualify this by stating that he believes Mr. Hunt is about right; at least, that the model is by far the best means.

The writer purposes to show that hydraulic models can be, and have been, constructed and operated so as to reproduce with accuracy

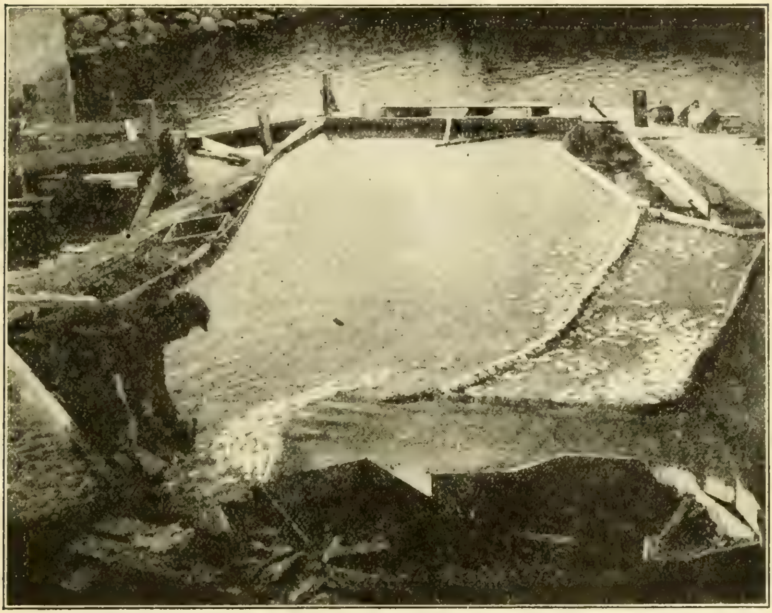

FIG. 8.—MODEL, SHOWING EFFECT OF TRANSPORTIVITY CONTROL.

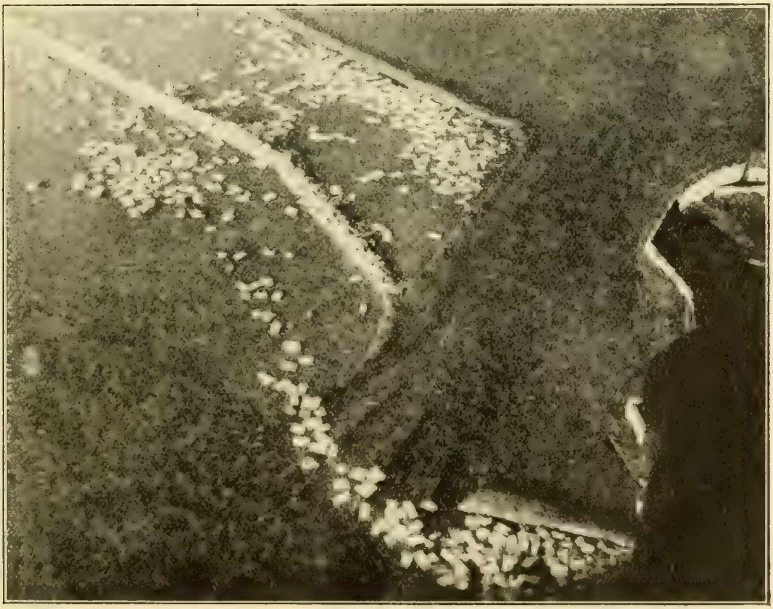

FIG. 9.—MODEL, SHOWING EFFECT OF TRANSPORTIVITY CONTROL.

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the performances of the corresponding full-size prototypes. This is especially true of the conditions of flow, and, when this is once grasped by hydraulic engineers, there will soon be no further lack of experimental data.

It will be demonstrated that, when a hydraulic model is constructed and tested under contemporaneous conditions of geometric and dynamic similarity, the reactions and velocities in the model are the relative counterparts of the corresponding reactions in the prototype, and that the counterparts include:

(1) Extraneous forces, such as gravitational forces, and centripetal forces or centrifugal reactions, when the latter are produced by the rotation of the model as a whole;
(2) Internal, centripetal forces, or centrifugal reactions; that is, those due to reactions between different masses in the model, as in an eddy, for example. This also includes tangential accelerations which, of course, are of the same dimensions as centripetal accelerations;
(3) Static and dynamic effects due to the necessarily imposed proportionality of heads and depths;
(4) Skin friction;
(5) Effects of wind, more particularly as regards its effect on the course of running ice;
(6) Transportation of detritus;
(7) Transportivity of the water for floatage;
(8) Time for the model is made consistent by reducing the period of time corresponding to observations on the prototype in the ratio of the square root of linear dimensions; if the unit of time is reduced in that ratio, a watch may be made for the model so that the time indicated by this watch will be numerically equal to that of the corresponding observation on the prototype taken by an ordinary watch; thus, time in the model becomes the counterpart of that actually;
(9) Measurements; besides time, scales of length, area, volume, weight, force, etc., may be based on the linear scale ratio, so that measurements of all kinds, including time, as mentioned above, may be made directly on the model, thus avoiding calculations to ascertain what the corresponding quantities should be for the prototype;
(10) Factors of safety in structures, provided the models are properly constructed and properly tested.

The question of viscosity, from a theoretical point of view, is less satisfactory, but the practical circumstances under which viscosity is operative are such that it may be treated with skin friction, on the theory that all hydraulic resistances finally result in dynamic reac-

Mr. Groat. tions converting kinetic energy into heat, through the medium of viscosity and kindred resistances.

However, it is certainly questionable to consider skin friction as due to viscosity unless a much narrower definition is given to skin friction than ordinarily. It is better to consider all obstructions to flow as offering direct resistances to the water, the translatory kinetic energy of which is immediately reduced in the direction of flow, the difference being converted into kinetic energy of turbulence and eddies, ultimately to be absorbed by viscosity friction.

Surface tension may become very troublesome if the model is not large enough. This subject needs much investigation. Surface tension has a preponderating influence on weirs when the head is very slight.

Although the intention is to confine the study to the theory of hydraulic models, much of what is said will apply directly to other types—model structures, for example—and thus an opportunity will be provided for investigating some of the alleged misdemeanors of models.

Theory of Hydraulic Models.—Several writers have given very brief and incomplete accounts of the theory of models, among which may be mentioned:

Routh, on "Elementary Rigid Dynamics" (1897), Articles 367 to 374, inclusive. These paragraphs relate to the principle of similitude in models and in other very interesting cases.

Stanton and Pannell, in a paper entitled "Similarity of Motion in Relation to the Surface Friction of Fluids." This is a British publication from the Collected Researches of the National Physical Laboratory, which paper every hydraulic engineer should study. The word "similarity" in the title of this paper is used in a somewhat different sense from that adopted in the present discussion.

The writer, in *Engineering Record,* September 25th, 1915, page 377.

Forchheimer, on "Hydraulik", page 33.

Buckingham, in *Transactions,* Am. Soc. Mech. Engrs., Vol. XVII (1915), on "Model Experiments and the Forms of Empirical Equations."

Durand, on Model Propellers, in Report 14 to the National Advisory Committee on Aeronautics, Washington.

The writer, in *Canadian Engineer,* February 14th, 1918, page 139.

Van Ornum, in "The Regulation of Rivers", devotes several pages to an interesting account of actual tests on models of portions of rivers.

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The ideal way to prove the equivalency of models and their prototypes would be to determine the performance of each by the theories of hydrodynamics, and then compare the results, homologue with homologue. The difficulties of integrating the partial differential equations for the simplest cases are so great, however, that the method must be abandoned for lack of time and perspicuity, if for no other reason.

Perhaps the first elementary step taken toward proving the principle of hydraulic similarity should be by way of the Chezy formula

$$v = c \sqrt{r\,s} \quad \ldots\ldots (1)$$

If we have a model of an actual river channel, and represent its elements by small Italic letters, allowing Equation (1) to indicate the relations for the model, then the corresponding elements for the river (prototype) will be represented by the capital Italics, and we shall have,

$$V = C \sqrt{R\,S} \quad \ldots\ldots (2)$$

Squaring and taking ratios,

$$\frac{\dfrac{v^2}{r}}{\dfrac{V^2}{R}} = \left(\frac{c}{C}\right)^2 \frac{s}{S} \quad \ldots\ldots (3)$$

If Roman capital letters now be understood to represent the ratios of corresponding small Italics to corresponding capital Italics, as $\mathbf{V} = \dfrac{v}{V}$,

$$\frac{\mathbf{V}^2}{\mathbf{R}} = \mathbf{C}^2\,\mathbf{S} \quad \ldots\ldots (4)$$

Now the model is geometrically similar to the prototype, so that, if we are to have hydraulic similarity, $\mathbf{S} = 1$. If the surface of the model is geometrically similar to that of the prototype, as supposed, we should also have $\mathbf{C} = 1$. Therefore,

$$\left.\begin{array}{l} \dfrac{\mathbf{V}^2}{\mathbf{R}} = 1 \\ \text{or,} \quad \dfrac{v^2}{r} = \dfrac{V^2}{R} \end{array}\right\} \quad \ldots\ldots (5)$$

Equation (5) shows that the velocities should be proportional to the square roots of the hydraulic radii, and, therefore, to the square roots of any homologous linear dimensions, by reason of geometric and hydraulic similarity, which latter extends to heads and depths as well as to any other linear wet dimensions. If the velocities and linear dimensions are not thus connected by Equation (5), the

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hydraulic slopes will not be equal, thus causing the similarity of flow to vanish.

Table 1,* giving Chezy coefficients, is unique, and shows at a glance that the value of *c*, as taken from the table, will be approximately constant when some attempt is made to select values in such a manner as to maintain a constant ratio between the probable dimensions of the irregularities of the surfaces and the hydraulic radius. The writer has tried this several times, with good results, but, to avoid any possible prejudice, invited a young man familiar with such matters to try it, thereby securing the results shown in Table 2, which need no explanation except to state that the average of the values of the Chezy coefficient for the larger and smaller of the radii compare as follows: $c = 106\frac{1}{8}$; $C = 104\frac{3}{8}$. This is a practical demonstration of the accuracy of model performance as representative of the flow in an actual channel. The only obstacle to more accurate work is the uncertainty as to the magnitudes of the irregularities of the surfaces, both actual and as indicated in the table.

The simple demonstration just given connects only the mean velocity, longitudinal surface profile of the water, mean depth, and irregularities of wet surface at each of the individual cross-sections of the model with the homologues in the prototype. It does prove, for example, that the hydraulic gradient is repeated to scale in the

TABLE 1.—VALUES OF *c* DEDUCED FROM DARCY AND BAZIN'S VALUES.

Hydraulic mean depth = *m*.	Very smooth channels. Cement.	Smooth channels. Ashlar or brickwork.	Rough channels. Rubble masonry.	Very rough channels. Canals in earth.	Excessively rough channels encumbered with detritus.	Hydraulic mean depth = *m*.	Very smooth channels. Cement.	Smooth channels. Ashlar or brickwork.	Rough channels. Rubble masonry.	Very rough channels. Canals in earth.	Excessively rough channels encumbered with detritus.
0.25	125	95	57	26	18.5	8.5	147	130	112	89	....
0.5	135	110	72	36	25.6	9.0	147	130	112	90	71
0.75	139	116	81	42	30.8	9.5	147	130	112	90	....
1.0	141	119	87	48	34.9	10.0	147	130	112	91	72
1.5	143	122	94	56	41.2	11	147	130	113	92	....
2.0	144	124	98	62	46.0	12	147	130	113	93	74
2.5	145	126	101	67	....	13	147	130	113	94	....
3.0	145	126	104	70	53	14	147	130	113	95	....
3.5	146	127	105	73	....	15	147	130	114	96	77
4.0	146	128	106	76	58	16	147	130	114	97	....
4.5	146	128	107	78	....	17	147	130	114	97	....
5.0	146	128	108	80	62	18	147	130	114	98	....
5.5	146	129	109	82	....	20	147	131	114	98	80
6.0	147	129	110	84	65	25	148	131	115	100	....
6.5	147	129	110	85	....	30	148	131	115	102	83
7.0	147	129	110	86	67	40	148	131	116	103	85
7.5	147	129	111	87	....	50	148	131	116	104	86
8.0	147	130	111	88	69	∞	148	131	117	108	91

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* Copied from Professor Unwin's article on "Hydraulics" in "The Encyclopedia Britannica", Vol. 14, p. 69, Eleventh Edition.

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TABLE 2.—COMPARISON OF CHEZY COEFFICIENTS FROM UNWIN'S TABLE IN "ENCYCLOPEDIA BRITANNICA."

Nature of channel.	Irregularities.	Ratio.	Hydraulic radius.	*C*. from Table.	Hydraulic radius.	*C*, from Table.
Smooth channels, cement.	1/64 in.	800‰	0.25	125	2.0	144
Smooth channels, brick...	1/8 in.		2.00	124	16.0	130
Smooth channels, brick...	1/8 in.	1 600‰	2.00	124	0.5	110
Rubble channels..........	2 in.		32.00	115	8.0	111
Rubble channels..........	2 in.	1 200‰	4.0	106	1.0	87
Rough canal in earth.....	2 ft.		4.8	104	12.0	93
Rough canal in earth.....	2 ft.	500‰	10.00	91	2.0	62
Very rough earth with detritus..................	10 ft.		50.00	86	10.0	72
Sum of smoother....................................				446	....	403
Sum of rougher....................................				429	....	406
Average of eight values, smoother....................				106⅛	....	....
" " " " rougher....................				104⅜	....	....

model, and that the wet surfaces of the model must be made geometrically similar to their homologues in every respect. It is, indeed, the virtual integrations "in parallel" of the differential equations for the model and prototype, making their hydraulic slopes (derivatives) equal, and, like integration, it requires the supposition of the existence of homologous depths and velocities, and equality of hydraulic slopes to begin and end with; that is, there must be limits for the integration.

This similarity suggests a practical fact which must be heeded very carefully when a model is to be tested. The conditions of flow surrounding the entrance and discharge of the water to and from the model must be properly adjusted, to represent exactly those existing in the prototype, or there will be no establishment of hydraulic similarity. When the prototype is merely a proposed construction, this part of the test must be determined by the most thorough investigation. When the prototype exists, the conditions of entrance and discharge must be reproduced exactly. This is confirmed by an extensive experience with the hydraulic models illustrated photographically in this paper.

The writer might proceed further with the interpretation of results, and show that any two homologous forces in model and prototype are bound to one fixed ratio. The skin frictions on homologous areas, for example, are in the same ratio as the weights of homologous volumes, or as the pressures of water on homologous areas. Demonstrations of such dynamical similarity, however, will be allowed to develop in the sequel.

The most serious objection to Equations (4) and (5) is that they do not extend to details of the flow, such as the distribution and directions of velocities, eddies, boilers, and other local disturbances.

Mr. Groat. That these, too, are reproduced in the model, will develop, either directly or as collateral results.

Another difficulty undoubtedly lies in the fact that the flow in a river is not steady, the particular configuration existing at one instant probably never again being exactly repeated. A rigid demonstration would draw on the theory of statistics to determine an average, as compared with an instantaneous configuration. Fortunately, actual experiments are of a statistical nature, especially if the effort is to determine average values rather than to record isolated instantaneous observations.

Verification.—Optical demonstration is very convincing. The map, Fig. 10, shows the results of actual comparison of model and prototype.* It represents a section of the St. Lawrence River where a current impinges on the head of an island at *N*, being thereby diverted partly into each of the two channels forming the island.

The quantity of water supplied the model was adjusted so that the mean velocity in the model would be proportional to the square root (1: 10) of the scale ratio, 1: 100. Approximate adjustments were made at the inlet and outlet of the model to secure proper entrance and discharge conditions as regards distribution of velocities and surface levels. The paths and velocities of floats, and the levels of the water surface at various points were then compared with the homologues observed in the actual river by means of the plottings shown on the map. The model was tested in 1917, whereas the observations on the prototype were those made in 1904 by John R. Freeman, M. Am. Soc. C. E. The hydrography of the river did not change in the meantime, owing to the stable nature of the channel.

The discharge in the model was for a stage of 3.8 at Gauge *A*, which was exactly the stage of the river when the actual surface elevations were observed as indicated. An extremely close agreement between individual pairs of homologous elevations need not be expected, because the elevations in the model were determined rather roughly by an ordinary rule held vertically on the heads of submerged nails serving as bench-marks. The rule was graduated to hundredths of a foot to conform to the scale ratio of 1: 100. A more perfect check on the correspondence of water surface levels can be made statistically by averaging all the level readings, having some regard for weights, as in Table 3.

The discrepancies of elevation being pretty well distributed between plus and minus, and the average elevations agreeing closely, it may be concluded that the contours of the water surface were well represented to scale in the model; moreover, the difference in level between *M*

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* The writer is indebted to Messrs. F. W. Ely and E. O. Garrett for much assistance in attending to the matter of constructing and testing the models and, at a much earlier date, to Mr. D. C. Walser for corresponding work in connection with a model built to a scale of 1 :1 000.

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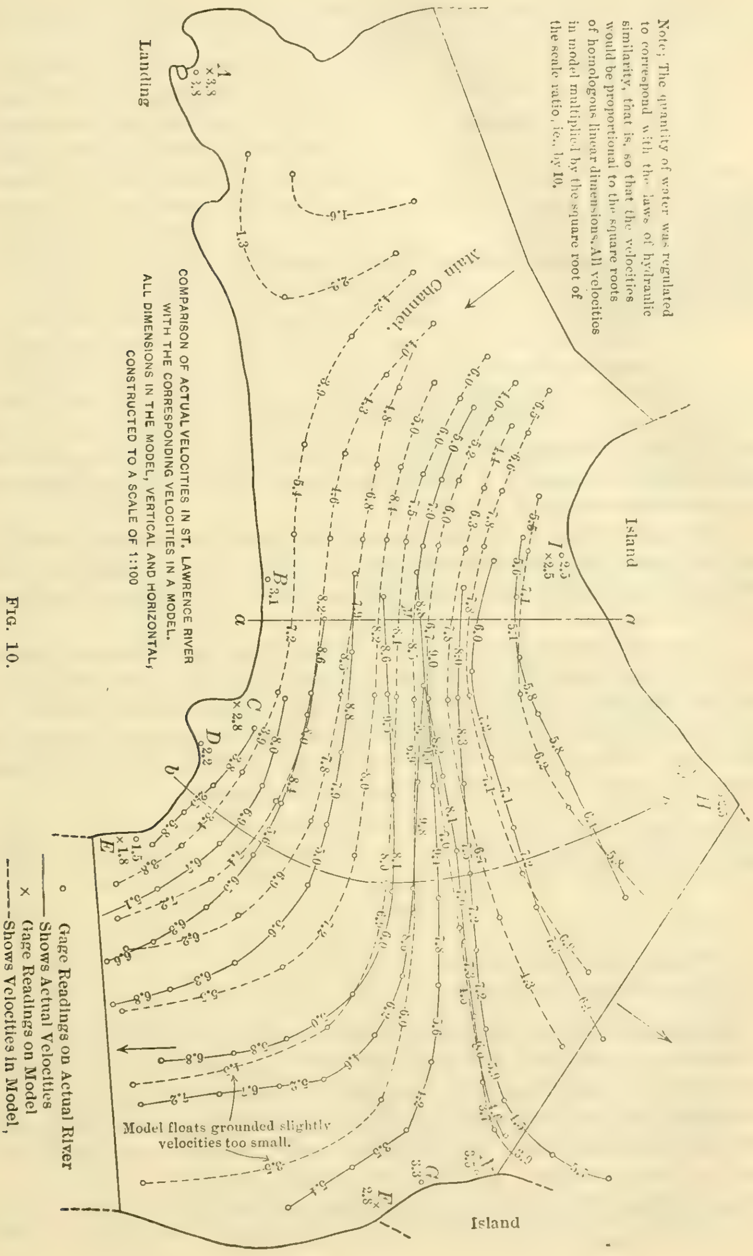
Landing
A ×3.8 ○3.8
Main Channel
Island
I ○2.5 ×2.5
a
B 3.1
C ×2.8
D 2.2
b
E ○1.5 ×1.8
H
G 3.3○
F 2.8×
Island
Model floats grounded slightly velocities too small.
○ Gage Readings on Actual River
—— Shows Actual Velocities
× Gage Readings on Model
- - - - Shows Velocities in Model,

Note; The quantity of water was regulated to correspond with the laws of hydraulic similarity, that is, so that the velocities would be proportional to the square roots of homologous linear dimensions. All velocities in model multiplied by the square root of the scale ratio, ie., by 10.

COMPARISON OF ACTUAL VELOCITIES IN ST. LAWRENCE RIVER WITH THE CORRESPONDING VELOCITIES IN A MODEL. ALL DIMENSIONS IN THE MODEL, VERTICAL AND HORIZONTAL, CONSTRUCTED TO A SCALE OF 1:100

FIG. 10.

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TABLE 3.—COMPARISON OF WATER SURFACE ELEVATIONS IN MODEL AND PROTOTYPE.

Remarks.	Elevation of Water Surface.	
	Model.	Prototype.
Elevations at Gauge *A*	3.8	3.8
Mean of elevations at *B* and *D*	....	2.65
Elevation at *C*	2.8	....
Elevations at *E*	1.8	1.5
Elevation at *F*, extrapolated from elevations at *G* and *N*	....	3.1*
Elevation at *F*	2.8	....
Elevations at *H*	3.0	2.5
Elevations at *I*	2.5	2.5
Average elevations	2.78	2.68

* Probably this elevation slightly too high.

and *N* for the model was slightly more than 0.01 ft., corresponding to something in excess of 1 ft. for the river, which latter difference in level is known to exist actually.

The stage of the river was about 4.5 at Gauge *A* when the velocities in the prototype were observed, but the stage in the model was 3.8, the same as for the level observations. This is a little unfortunate, but will only add interest to the comparison.

A careful examination of the cross-section and discharge curve of the river shows that the mean velocities in the cross-section for the two stages should be in the ratio of 7.45 ft. per sec. to 7.07 ft. per sec., or 1.053. By a study of surface velocities on the map along the lines *a-a* and *b-b*, the following comparison of river surface velocities with model surface velocities was made:

	a-a	*b-b*
Actual river (higher stage)	8.08	7.99
Model (lower stage)	7.71	7.60
Ratio	1.047	1.051

Average ratio 1.049
Check from above ratio.......................... 1.053

As the numerators are based on observation of actual river surface velocities, and the denominators are from the model tests, the close agreement of the ratios thus determined with the ratio of the mean velocities for the two stages, based on the discharge curve, shows that the general distribution of velocities in the model must agree with that in the prototype. To illustrate further, we have:

$$\frac{\text{Mean velocity in Section } a\text{-}a \text{ (actual discharge curve)}}{\text{Maximum surface velocity in Section } a\text{-}a \text{ (model)}} = \frac{7.07}{8.5} = 83\%,$$

which is about the percentage that might be expected, as it is known that similar ratios are in the vicinity of 80% for such channels. Of course, the discharge of the river for a stage of 3.8 might now be computed from the observed discharge of the model for that stage. It may also be added that the large eddy shown in the model above Gauge *A* occurs in the river just as reproduced in miniature. Indeed, that was one of the main criteria used in the model test to indicate when the entrance conditions were proper, the importance of which has been mentioned. Mr. Groat.

*Theory of Dynamic Similarity.**—The preceding discussion relates particularly to the flow in channels, and does not extend to details. A brief statement of the principles of dynamic similarity will be made, and will be extended to the details of flow in hydraulic models.

Dynamically similar systems are such that all the forces in one system bear a constant ratio to their homologues in any of the others, and the lines of action in any two of the systems form geometrically similar configurations in space. An example familiar to engineers is afforded by two similar stress diagrams in conjunction with similar space diagrams.

Similar systems of masses are such that all the masses in one system bear a constant ratio to their homologues in any of the others, and the space distributions of mass in any two of the systems correspond to geometrical similarity.

Newton established the fact that, if two similar systems of masses are acted on by similar systems of forces which are proportional to the masses on which they act, the motions of the masses will remain similar, homologue for homologue, if their motions were similar to begin with.

There may now be added to these statements the following practical theorem which throws an entirely new light on the theory of models, generally, and proves, in particular, that when hydraulic models are properly constructed and properly tested, they must reproduce, even in details, the performances of their prototypes:

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* The term "dynamical similarity" has a somewhat different meaning from that used by Buckingham and Durand in the important papers referred to on page 804. The writer intends to require similar motions (that is, average motions which are similar) as well as similar systems of forces and geometrically similar solids with similar distributions of mass. This implies that the motions of homologous elementary masses describe paths which are geometrically similar. For this reason there is a bond between speed and linear dimensions, as in Equations (9) and (10), that cannot be broken.

Even if gravity is neglected, homologous centripetal accelerations (tangential also) must be in a certain ratio, and this connects velocities with linear dimensions. Consequently, the scale ratio of a model becomes either a wholly independent variable on which velocity depends or a parameter of magnitude determined by some additional condition of the problem, the latter being generally the case, as in the discussion of viscosity.

To increase the number of independent variables in the case of tests on air propellers the writer thinks the artifice of using air under pressures and temperatures differing from the atmospheric pressure and temperature might be tried, as also the artifice of changing the fluid altogether.

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When the velocities of homologous masses of floatage, water, suspended materials, and detritus, flowing similarly in two geometrically similar channels, are proportional to the square roots of homologous linear dimensions, then, according to kind, all the boundary and internal force reactions of practical moment, in both streams, form distinct pairs of similar systems of forces, any two homologues of which are in a fixed ratio, namely, that of corresponding homologous extraneous forces; provided the conditions of flow are sufficiently removed from those of pure stream-line flow to admit of the application of the ordinary theories of hydraulic friction, wind reactions, and transportation of detritus.

Therefore, when the theories apply, the similarity of motion must persist when once established.

When the proviso is satisfied, this theorem amounts to parallel integrations extended throughout the volume of the streams of masses and over their boundaries, including the free surfaces and terminal cross-sections. It follows that, if similarity of flow exists at the two terminal sections, the conditions of flow in the two channels will be similar, and the similarity will extend to details, the minuteness of which, in practical operations, will depend on the care and intelligence exercised in making use of the theory. It will be shown hereinafter that the proviso becomes redundant if the size of the model is properly determined.

To prove the theorem, the following notation will be adopted:

Notation.—Homologous quantities are represented by Italic or Greek capitals and their corresponding minuscules. Small letters relate to the model, capitals to the prototype. A Roman capital indicates the ratio of the two corresponding magnitudes, the numerators relating to the model, as $\mathrm{V} = v \div V$. The meanings of the characters are defined as follows:

a = area, homologue A, for example;
δ, Δ = densities of homologous masses;
f = force, primarily extraneous forces acting on a mass;
ϕ, Φ = force of skin friction;
g = acceleration of gravity at surface of earth;
γ, Γ = homologous accelerations when the masses are at different places, or when, by artificial means, the extraneous forces are made to differ from, or combine with, gravitational forces;
l = length;
m = mass;
μ, M = coefficients of viscosity for the case where different fluids flow in model and prototype;

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ν, N = kinematical coefficients of viscosity corresponding to above coefficients of viscosity; note that $\nu = \mu \div \delta$;
q = volume;
r = radius of curvature at point in path of moving mass;
s = specific weight of a stone, pebble, grain of sand; also a stress;
t = time;
ψ, Ψ = force of viscosity friction;
v = velocity;
w = weight;
ω, Ω = homologous specific weights.

Mass Ratio.—If two homologous masses in model and prototype are compared, supposing that solids of the same kind have a uniform density in the prototype and are represented by homologous masses of uniform density in the model, their ratio, of course, will be the same, whatever particular pair of homologues is selected. This is called the mass ratio, which is formally expressed by

$$\text{Mass ratio} = \mathbf{M} = \frac{m}{M} = \frac{\frac{\omega}{\gamma}\, l^3}{\frac{\Omega}{\Gamma}\, L^3} = \frac{\delta\, l^3}{\Delta\, L^3} = \mathbf{D}\,\mathbf{L}^3 \ldots\ldots\ldots (6)$$

Force Ratio.—In similar manner, there is a fixed ratio for homologous extraneous forces, as for gravitational forces, and the theorem above shows that all other kinds of forces must appear in model and prototype in homologous pairs having this same ratio. Thus:

$$(1)\ \text{Force ratio} = \mathbf{F} = \frac{f}{F} = \frac{m\,\gamma}{M\,\Gamma} = \mathbf{M}\,\mathbf{G} = \mathbf{D}\,\mathbf{L}^3\,\mathbf{G} \ldots\ldots (7)$$

When $\mathbf{G} = 1$, it is plain that $\mathbf{M} = \mathbf{F}$, in Equation (6), which is the case when the tests are conducted at the same place on the earth's surface.

(2) *Centrifugal Reactions.*—All classes of forces must be related, so that the ratio of any two homologues will be equal to the force ratio, Equation (7). Thus, homologous centrifugal reactions will be in this ratio when the velocity ratio is determined by,

$$\mathbf{F} = \frac{m\,\frac{v^2}{r}}{M\,\frac{V^2}{R}} = \frac{\mathbf{M}\,\mathbf{V}^2}{\mathbf{R}} \ldots\ldots\ \ldots\ldots\ldots\ldots (8)$$

Mr. Groat. where r and R represent homologous radii of curvature for similar masses. As $r : R = l : L$, for similar paths we must have, from Equations (7) and (8):

$$\left.\begin{aligned} \mathbf{M\,G} &= \frac{\mathbf{M\,V}^2}{\mathbf{L}} \\ \text{or,}\qquad \mathbf{G} &= \frac{\mathbf{V}^2}{\mathbf{L}} \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

The interpretation of this last equation is that, when model and prototype are tested under different intensities of extraneous forces, homologous centripetal accelerations must be proportional to homologous gravitational accelerations, in order to preserve proper force relations.

If both model and prototype are tested under equal intensities of extraneous forces, as at the earth's surface, we have

$$\left.\begin{aligned} \gamma = \Gamma &= g \\ \text{or,}\qquad \frac{\gamma}{\Gamma} = \mathbf{G} &= 1 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

which proves that homologous centripetal accelerations are equal in such cases; that is $v^2 \div r = V^2 \div R$.

(3) *Proportionality of Heads and Depths.*—It is tacitly assumed in the theorem that homologous heads and depths are in the same proportion as homologous linear dimensions of the rigid portions of the model; that is, the volumes occupied by the water, or fluids, in model and prototype, are geometrically similar. It is necessary, therefore, to show that this assumption is not inconsistent with the requirements of hydraulic similarity; particularly that the hydraulic pressures and reactions on homologous portions of the boundary, or wet surface, meet the requirements of the force ratio, Equation (7). The ratio of any two homologous static pressures is

$$\frac{\omega\, h\, l^2}{\Omega\, H\, L^2} = \frac{\gamma}{\Gamma}\;\frac{\dfrac{\omega}{\gamma}\, l^3}{\dfrac{\Omega}{\Gamma}\, L^3} = \mathbf{G\,D\,L}^3 = \mathbf{F} \ldots\ldots\ldots\ldots (11)$$

by applying Equation (7).

Therefore, under the conditions imposed by Equation (9), the assumption of proportional homologous heads is consistent, whatever the size of the model.

(4) *Skin Frictions.*—If the surface of the model is geometrically similar to its prototype, the coefficients of skin friction for model and prototype are equal. Then the ordinary theory requires that the

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resisting frictional forces along any two homologous surfaces are proportional to their areas and to the squares of the respective velocities along the surfaces, and therefore to the homologous areas and squares of any two homologous velocities. If the fluids in model and prototype are different, these frictions are altered in the direct ratio of densities. Therefore, the ratio of homologues is

$$\frac{\phi}{\Phi} = \frac{\delta\ l^2\ v^2}{\Delta\ L^2\ V^2} = \mathbf{D}\ \mathbf{L}^3\ \frac{\mathbf{V}^2}{\mathbf{L}} = \mathbf{D}\ \mathbf{L}^3\ \mathbf{G} = \mathbf{F} \ldots\ldots\ldots\ldots (12)$$

by Equation (7).

Therefore, under the conditions imposed by Equation (9), homologous frictions satisfy the requirement of the force ratio, whatever the size of the model.

(5) and (7) *Wind Friction.*—All fluid friction follows laws substantially the same as for water. Then the same reasoning as used for skin friction can be applied to the case of homologous cakes of ice acted on by wind, and to the motion of the ice through the water by reason of that action. If the cakes of ice rise sufficiently above the surface of the water to offer obstruction to the wind, the resulting pressures are subject to laws similar to those yet to be discussed in connection with the pressures of water on stones and other detritus when lying on the river bed, where it is shown that such pressures satisfy the force ratio. Therefore, it may be accepted that wind reactions go with skin friction; one being shown to satisfy the requirement of hydraulic similarity, the other does also. Of course, it will be understood that wind velocities for the model are determined in the same manner as fluid velocities of any kind, that is, they are to be proportional to the square roots of homologous linear dimensions, when model and prototype are tested with one liquid at the same place. Just how to create a breeze for a model is a practical question which may be simplified by testing the model in the open air when the breeze is of the correct intensity. Thus, a 5-mile breeze would be equivalent to a 50-mile gale when the scale of the model is 1 : 100.

(6) *Movement and Transportation of Detritus.*—This is one more action which must be heeded in constructing and testing a model of a channel which conducts water loaded with detritus. The density of any such materials is greater than that of water. Therefore, detritus diversion is the antithesis of ice diversion. Ice is floatage; detritus is "sinkage," to coin a new word (with apologies to Mr. Leighton).

The writer's experiments on models have included observations of the effects produced by currents in moving gravel and stones on the stream bed. To reproduce the effects in miniature, the river gravel must be sorted by screening so as to obtain the correct percentages of the different sizes. The gravel for the model is then screened and

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mixed to correspond. The mean diameter of a model pebble, for example, must bear the same ratio to the mean diameter of the homologue in the actual stream that the linear dimensions of the model bear to the corresponding dimensions of the stream. If the model is not too small, imitation of performance under conditions of hydraulic similarity in the model will be surprising.

The average size of stones for a fill in swift water was determined by using a model, the experiments showing that the fill could be constructed across the stream up to a certain elevation which was the higher for the larger of any two sizes, and that the fill could be brought entirely above the water surface for sizes greater than a certain limiting size. Stones of the limiting size, and larger, now lie quiescent on the bed of the actual river at the place represented by the model. The model, too, was of a very small scale, only 1:100.

That such should be the facts may be proved theoretically. Merriman shows,* by simple assumptions, that the transporting capacity of a stream, measured by the weight of the heaviest stones which the current of water will move, is proportional to the sixth power of the impinging velocity. This proposition is accepted, with the qualification that it applies to geometrically similar shapes for stones of given material, of given density, and of consistent condition of surface. It is very evident that it could not apply, for example, to two stones one of which was spherical and the other cubical, or to two similar spalls of the same size and shape, one being clean and the other coated with slimy moss.

Merriman's assumptions imply that the force of a fluid impinging on an obstruction is jointly proportional to the obstructing area and the square of the impinging velocity. The writer extends the assumption by including the density of the fluid. When different fluids are flowing in model and prototype, and the latter are subject to different intensities of extraneous forces, the ratio of the transporting powers of the two streams, measured by the weight of the stones they will move, is

$$\frac{s}{S}\,\mathbf{L}^3 = \frac{\mathbf{S}}{\mathbf{G}}\,\mathbf{G}\,\mathbf{L}^3 = \mathbf{D}_s\,\mathbf{G}\,\mathbf{L}^3 \dots\dots\dots\dots\dots\dots (13)$$

where $\mathbf{D}_s$ is the ratio of the densities of geometrically similar stones similarly situated in model and prototype. It is apparent, therefore, by Equation (7), that hydraulic and dynamic similarity can exist only when

$$\mathbf{D}_s = \mathbf{D},$$

that is, only when the densities of homologous stones are proportional to the densities of the fluids in model and prototype, homologue to

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* "Treatise on Hydraulics" (1908), Art. 127, p. 323.

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homologue. When the fluids are the same, $\mathbf{D} = 1$, and homologous stones must be of the same density. The weights of the stones in Equation (13) form two similar systems of forces acting on homologous masses when $\mathbf{D}_s = \mathbf{D}$.

It still remains to be shown that the system of dislodgment forces also satisfies the force ratio, Equation (7), when the dynamic requirements of Equation (9) are imposed.

The assumptions require a dislodgment force ratio of

$$\mathbf{D\,A\,V^2 = D\,L^2\,V^2 = D\,L^3\frac{V^2}{R} = D\,L^3\,G} \ldots\ldots\ldots\ldots (15)$$

which shows that such forces are in harmony with hydraulic similarity by Equations (7) and (9).

Therefore, the ratio of the mean diameter of detritus transported by the model to that of detritus transported by the prototype is the same as the scale ratio, if Merriman's assumptions are correct. That is to say, if the model detritus is properly selected, sorted, proportioned, and introduced into the model under conditions of hydraulic and geometric similarity, the transporting phenomena of the stream should be reproduced in the model, a fact which is almost axiomatic, but, along with the theory of models, seems not to have had sufficient, if any, recognition.

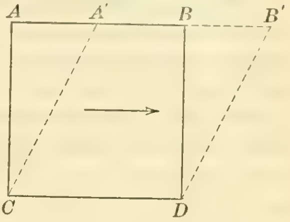

FIG. 11.

It should be carefully noted that homologous pebbles in model and prototype must be similarly situated on the beds of their respective channels.

Viscosity.—This property of fluids requires special attention in its relation to hydraulic models because its effects are not independent of the size of the model, as has been the case with all the other phenomena thus far discussed. Nevertheless, it is a subject which can be handled satisfactorily if theoretical relations are regarded.

As calculations involving viscosity are relatively infrequent, it will be well to refresh the memory as to these matters. Fig. 11 represents a small imaginary cube immersed in a liquid flowing in the direction of the arrow, the velocity of the fluid being graded uniformly in the increasing sense from the face, *CD*, to the face, *AB*. The value of the velocity along *CD* is v; along *AB* it is $v + dv$. If, then, the cube is imagined to move with the water so as to enclose constantly all the particles contained at the outset, a shearing distortion takes place, and the cube, or prism, becomes a parallelopiped, of cross-section *A′ B′ CD*.

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If the face, *AB*, has the area, *a*, and the edge, $AC = BD$, is of length, dx, then experiment indicates that

$$\psi = \mu\, a\, \frac{dv}{dx},$$

where ψ is the viscosity friction, or force, on the area, *a*, necessary to produce the distortion, and μ is the coefficient of viscosity. Observe that this viscosity friction on the face, *a*, is proportional to the transverse velocity gradient, $dv \div dx$. Observe, also, that the dimensions of $dv \div dx$ are the same as those of $v \div l$. Therefore, the viscous reaction taking place between the contiguous masses of fluid subjected to shearing distortion has the dimensional form,

$$\psi = \mu\, a\, \frac{v}{l} = \mu\, \frac{l^2}{l}\, v = \mu\, l\, v \ldots\ldots\ldots\ldots\ldots\ldots (16)$$

Consequently, the force ratio for viscosity reactions is

$$\frac{\psi}{\Psi} = \frac{\mu\, l\, v}{M\, L\, V} = \mathbf{M'}\, \mathbf{L}\, \mathbf{V} \ldots\ldots\ldots\ldots\ldots\ldots (17)$$

where $\mathbf{M'} = \mu \div M$.

This is the first ratio examined, with the exception of Equation (8), which did not satisfy the force ratio, Equation (7), without modification of the assumptions. In Equation (8) it was necessary to regulate the velocity, as indicated by Equation (9), before similarity could be established. In Equation (17) it is necessary to determine the scale ratio, **L**, of the model. Thus, equating Equations (7) and (17),

$$\mathbf{D}\, \mathbf{L}^3\, \mathbf{G} = \mathbf{M'}\, \mathbf{L}\, \mathbf{V} \ldots\ldots\ldots\ldots\ldots\ldots (18)$$

or

$$\mathbf{L}^2\, \mathbf{G} = \mathbf{N}\, \mathbf{V}$$

and

$$\mathbf{L}^{\frac{3}{2}} = \mathbf{N}\, \mathbf{G}^{-\frac{1}{2}} \ldots\ldots\ldots\ldots\ldots\ldots (19)$$

by applying Equation (9).

This shows that cases of pure stream-line flow cannot be reproduced in models unless the sizes of the models are properly determined by Equation (19).

When such models and their prototypes are tested under the influence of extraneous forces of equal intensity, $\mathbf{G} = 1$. When the fluid is the same in model and prototype, $\mathbf{N} = 1$. It follows that, in such cases, $\mathbf{L} = 1$, by Equation (19). Therefore, models will not reproduce similar conditions of flow when it is attempted to test them and their prototypes for stream-line configurations of water (any one fluid) at the same place on the earth's surface.

If, instead of eliminating **V**, as in obtaining Equation (19), **G** is eliminated by Equation (9), there results,

$$\left.\begin{array}{l} \mathbf{L}\, \mathbf{V} = \mathbf{N} \\ \text{or,} \\ \dfrac{v\, l}{\nu} = \dfrac{V\, L}{N} \end{array}\right\} \ldots\ldots\ldots\ldots\ldots\ldots (20)$$

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This appears to harmonize perfectly with Reynold's discovery for geometrically similar tubes, which states that $\frac{v_c\,d}{\nu} = \text{constant}$, where v_c is Reynold's critical velocity and d is the diameter of the tube, ν being the kinematical coefficient of viscosity. It also appears to correspond very beautifully with Stanton and Pannell's plotting of the actual observations of the flow of water, air, and oil in pipes, the points all falling on one curve, irrespective of the fluid.

In the application of the theory to a model and prototype conveying the same fluid, it would appear, on superficial examination, that Equation (20) indicates similarity if the model is of any size, the velocity being regulated so as to be inversely proportional to the linear dimensions. This, however, is not the case, because the velocity is a function of the linear dimensions, by Equations (18) and (19), and not an independent variable in Equation (20), being, in reality, connected to the linear dimensions by Equation (9).

Thus we should not eliminate **G** from Equation (18), but **V**, or **L**, instead, because **G**, as a general thing, is equal to unity. If not, it should still be considered as fixed, as the model and prototype will be tested under fixed conditions of extraneous forces, which fact determines the value of **G**, and thus the relation between v and l, that is, the relation of **V** to **L**.

Equation (19)* determines the scale ratio of the model, and, thereby, the concomitant velocity when the places of observation and the particular fluids used are given. This equation shows that, theoretically, the same fluid may be used in both model and prototype, provided we are allowed to test under different intensities of extraneous forces. With $\mathbf{G} = 1$, Equation (19) shows that the model requires a different fluid from that for the prototype when both observations are made at the same place.

In case of different fluids, with $\mathbf{G} = 1$, **V** determined by Equation (9), and **L** determined by Equation (19), the extraneous forces, internal reactions, static and dynamic pressures, skin frictions, wind effects, resistances due to obstructions and transportation of detritus, transportivity and resistances due to floatage, and viscosity resistances form two dynamically and geometrically similar systems in which all pairs of homologous losses, including the total losses, are jointly proportional to densities, areas, and squares of homologous velocities. This does not mean that hydraulic gradients in the model or prototype are proportional to the squares of the velocities, for they may be of any magnitude. For example, in pure stream-line flow the gradient is

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* As examples of the uses of Equation (19), when $\mathbf{G} = 1$ it may be shown: (*a*) that a model air propeller in mercury at 20° cent. should be one-twenty-fifth full size for the prototype in air at 15° cent.; (*b*) that the scale-ratio of a model water-wheel tested in mercury at 20° cent., should be about 0.22 for the prototype in water at 15° cent. If the mercury can be at 100° cent., the scale-ratio would be about one-seventh. The effect of changing the density of air for a model has not yet been investigated.

Mr. Groat. proportional to v. The theorem simply shows that whatever the slope in the prototype, the homologue in the model will be the same if the size of the model is properly chosen.

What we have done is to show that the conditions of geometric and dynamical similarity can be imposed simultaneously in a hydraulic model so that it will reproduce the prototype both in form and action, and that this possibility is in full accord with the generally accepted laws of turbulent stream flow, including viscosity resistances.

(8) and (9) *Observations and Measurements.*—If the duration of time observations on the prototype is always reduced in proportion to the square root of the scale ratio* (linear dimensions), then all velocities and quantities of discharge when measured to the reduced scale will be equal to the corresponding quantities measured to full-scale units in the prototype. The analogy may be made perfect by graduating a watch dial to time units reduced in the proportion of the square root of the scale ratio,* and providing measuring instruments, graduated to scale, for lengths, volumes, weights, etc. When this is done, all measurements taken on the model will be numerically equal to the homologues observed in the prototype with full-size measuring instruments and an ordinary timepiece. Such a procedure will eliminate many calculations, for example, calculating the discharge by the formula, $\mathbf{Q} = \mathbf{H}^{\frac{5}{2}}$. The actual time required for a sand-bar to form in a model built to a scale of 1:100, for example, will be only 2 days, when the corresponding bar in the river forms in 20 days. The time indicated on the specially graduated watch, however, will be 20 scale-days.

(10) *Factors of Safety in Models.*—In making models of structures to test to destruction, it is a mistake to use the same materials as in constructing the prototype. If the test is simply to determine relative stresses in the various members, it is unimportant what materials are used, if care is taken to see that elastic properties are correctly proportioned. If the model is for mere appearance, little or no heed need be given the internal qualities.

To examine the matter of stress in homologous members we use the method of dimensions, as heretofore. The dimensions of stress are,

$$s = \frac{f}{a} = \frac{\omega\, l^3}{l^2} = \omega\, l$$

or

$$\text{stress ratio} = \mathbf{S} = \frac{s}{S} = \frac{\omega}{\Omega} L$$

If the safe stresses of the materials of model and prototype are indicated by the subscript m, then the correct scale ratio of the model to develop equal factors of safety is determined by

$$\mathbf{L} = \frac{\Omega}{\omega} \cdot \frac{s_m}{S_m}$$

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* When the intensities of extraneous forces differ between model and prototype, the correct time ratio is $\mathbf{T} = \sqrt{\mathbf{L} \div \mathbf{G}}$.

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If, for any good reason, it is desired to build the model of the same materials as used in the prototype and still develop equal factors, this condition can be taken care of by increasing artificially the specific weight of the material of the model until the two specific weights are inversely proportional to the desired scale ratio, that is, $s_m = S_m$ and $\mathbf{L} = \Omega \div \omega$.

This increase of the intensities of extraneous forces is most neatly accomplished by rotating the model as a whole about a vertical axis at considerable distance. The model must be placed, relative to the axis of rotation, so that the resultants of the action of gravity and the centrifugal reactions will be of the correct amounts and in the right direction relative to the model. Of course, the individual model structural members can be properly loaded to give the same results. The use of properly chosen materials for the model would seem to be the most scientific method.

The principal difficulty connected with the construction of a model with the same materials as used in prototype is that of securing model shapes of the same elastic properties as those of their homologues. A piano wire may have a strength of several hundred thousand pounds per square inch, whereas one would expect nothing of the sort in rounds of 2 or 3 in. diameter.

Professor Fletcher states that "the inexorable laws of mechanics forbid any such sweeping general conclusions." The writer's idea of mechanical laws is that they were devised expressly for the purpose of making such conclusions, and that they are themselves the most sweeping of all general conclusions.

Although model structures do not appear important as illuminating the question of hydraulic models, it is certain that model structures can be built and tested to show comparative results. It will be a service to negate to some extent any sweeping negative conclusion concerning their value.

It is perfectly proper to warn against all pitfalls connected with models. The real caution, however, is not against the use of models, but against their misuse.

Had the model water tank been constructed of appropriate materials, or, if necessary to test it when built of the materials used in constructing the prototype, had it been tested under proper conditions of loading, or of rotation, it would have developed the necessary stresses, and they would have been properly distributed among its members.

The elevated railway was not tested under conditions of mechanical similarity, as the speed of the engine was reduced by the direct scale ratio, instead of by its square root. If the radius of the full-size curve was 50 ft., as stated by Mr. Tratman, and the radius of the corresponding curve in the model 6¼ ft., as stated by Professor Fletcher, cor-

Mr. Groat. responding to a scale ratio of 1:8, then the proper speed ratio would be $1:\sqrt{8}$, or 1:2.83. Taking the velocity of 66 ft. per sec. for the full-size engine, as given by Professor Fletcher, the correct speed for the model should have been 66 ÷ 2.83 = 23.3 ft. per sec., approximately.

Had this speed been maintained at 23.3 ft. per sec. on a model structure properly built to scale, and on curves of any radius, homologous centrifugal reactions would be in proper proportion (the force ratio would be that of the weights of the two engines) and every member of the structure would receive its proper proportion of dead and live loads. Moreover, if the strengths of the materials were properly proportioned, the factors of safety in model and prototype would have been equal. It is not doubted that it would be something of an undertaking to construct and test such a model, but the fact which we have proved is that it can be done.

The writer is glad to note that Professor Fletcher finds the law of similarity satisfactory for the case of static pressures on a model dam. In the case of a dam and a geometrically similar model of one-ninth linear dimensions, the model operating under one-ninth the head on the prototype, the law of similar statics is proved by writing,

$$\text{static force ratio} = \left.\frac{\omega}{\Omega} \times \mathbf{H}^2 \times \mathbf{H} = \frac{\omega}{\Omega}\,\mathbf{H}^3 = 9^3\right]_{\omega = \Omega}$$

$$\mathbf{H} = \frac{H}{h}$$

Then, for dynamic conditions, the corresponding relative discharges of the two similar dams would be $\mathbf{H}^{\frac{5}{2}}$, and the power ratio, evidently, $\mathbf{H}^{\frac{7}{2}}$. To obtain the relative dynamic forces acting on any two homologous areas of overfall, it is simply necessary to divide the power ratio by the velocity ratio, that is, by the subduplicate ratio of heads. Hence, the corresponding force ratio is,

$$\text{dynamic force ratio} = \mathbf{H}^{\frac{7}{2}} \div \mathbf{H}^{\frac{1}{2}} = \mathbf{H}^3 = 9^3,$$

which is just the same as that deduced for static conditions.

Therefore, homologous hydrodynamic forces and homologous hydrostatic forces are in the same ratio all over the entire wet areas of any two similar dams. Moreover, if the two similar dams are built of materials having the same density, then their weights, indeed their volumes, are also in this same ratio; namely, the force ratio of the homology. The dynamics of similar dams are consistent with the statics. It is entirely incorrect to refer the fall of water to the center of gravity of the overfall. This notion must be eradicated.

The writer thinks he has answered all objections in the discussion on detritus, and hopes Mr. Leighton will become sufficiently interested in models to have one actually tried out under conditions of hydraulic similarity.

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PAPERS AND DISCUSSIONS

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THE DISTRIBUTION OF STRESSES IN MITERING LOCK-GATES, WITH SPECIAL REFERENCE TO THE GATES ON THE PANAMA CANAL

Discussion*

By David A. Molitor, M. Am. Soc. C. E.

David A. Molitor,† M. Am. Soc. C. E. (by letter).‡—The subject of this paper is one with which the writer was concerned as early as 1893, in connection with the steel gates of the Poe Lock at Sault Ste. Marie, Mich., and several times since, until 1912, in connection with the Keokuk Canal lock. Mr. Molitor.

While engaged on the Panama Canal work, in 1907-08, as designing engineer of the emergency dams, at the same time that the author was similarly engaged on the design of lock gates, this paper was practically prepared, and little of any consequence happened with which the writer was not conversant. It is surprising, therefore, that the paper should appear at this late date, especially when the method was published previously in the United States Deep Waterways' report of 1900.

It is admittedly true that this problem is fairly simple in principle, but, when the cumbersome analytic method of least work is used, it assumes enormous proportions when dealing with many redundants. The somewhat laborious computations alluded to in the paper actually occupied the author's entire time for more than a month, with the assistance of two engineers and one draftsman, working with the aid

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[*] This discussion of the paper by Henry Goldmark, M. Am. Soc. C. E., was received too late to be printed with that paper in *Transactions*, Am. Soc. C. E., Vol. LXXXI, p. 1621.

[†] Detroit, Mich.

[‡] Received by the Secretary, February 19th, 1918.

Mr. Molitor.

of practically every known computing device, from the "Millionaire" multiplying machine, down to the Thacher rule.

The author's term "theory of elastic work" would make it appear that he was proposing something novel. His Equation (7) expresses Menabrea's law, or "theorem of least work", which—stated in words—means that "the redundant or indeterminate conditions, reduce the actual work of deformation of a frame (or isotropic body) to a minimum". Hence there can be no doubt regarding the theorem on which the author bases his solution.

That this solution is "more complete and accurate than any previously developed" cannot be admitted at this time, though it was true at the time of publication in 1900.

The author has had ample opportunity to familiarize himself with the far more elegant and practical method of deflections frequently brought to his attention by the writer, but apparently he could not divorce himself from his older friend "least work".

A casual reading of the paper will show that the preliminary computations, necessary for the coefficients involved in the final equations, are very laborious and had to be largely omitted. The solution of the final equations is really a minor portion of the whole work. The numerical coefficients in these equations are all large numbers, about the million mark, which the author abbreviated to five significant figures. They represent complex functions which cannot be appraised accurately by any check methods, so that duplicate computations are necessary before attempting the solution of the final equations.

The substitution of the static equilibrium conditions—Equations (1) and (2)—into the work equations also involves considerable labor.

If the effect of shearing stresses was included, such a problem would prove almost prohibitive, and yet it cannot be assumed that these are negligible quantities, by any means. The deflections of the horizontal arches due to shear alone are usually about 10% of those due to bending only; and, for the vertical stiffeners, the difference might be greater or less, depending on the style of web, which is part open and part solid.

All these difficulties are obviated by using Professor Mohr's work equations in conjunction with Professor Maxwell's law as a basis for the analysis. This leads to the far more elegant and comprehensive method of deflections, by which the preliminary computations are vastly reduced, especially when the required deflections are found by graphic methods.

The coefficients in the final equations then represent deflections which can be expressed in inches to three, possibly four, significant figures, and the final solution of these equations can be effected with an ordinary 10-in. slide-rule. Furthermore, the preliminary computations are practically done away with, because the deflections are all

Mr. Molitor.

found from graphic deflection diagrams, which are easily and quickly drawn, and yield results which are more accurate than the analytic, besides being readily checked.

This is true, because a deflection diagram can be drawn for the combined effect of shear, bending, and direct stress, for a variable moment of inertia in any girder, which problem would lead to insurmountable difficulties, if attempted analytically. It is in this one respect that the author is compelled to make approximations which are wholly unnecessary. Thus, working with average cross-sections, average moments of inertia, and neglecting shear, will certainly not lead to the same high degree of accuracy as when these factors are duly considered. Also, by an appropriate choice of scales and pole distances, any desired accuracy can be attained by graphics, as, for instance, 20 000 times actual to the scale of lengths chosen.

To verify all this, the writer solved the same problem complete in 32 working hours, with the help of one assistant and a 10-in. slide-rule. This included drawing all deflection diagrams and solving the equations. It was proposed at the time to utilize this problem as a chapter in the writer's treatise* then in course of preparation, but, owing to the great number of tabulated computations and diagrams involved, it was decided later to exemplify the method on a smaller problem, thus adding to the clearness of presentation which would otherwise become obscured by a mass of figures. The complete theory and solution of this problem is illustrated on one of the 1909 steel gates of the Erie Canal, which, together with a full discussion, constitutes Chapter XIV of the above named treatise. All the fundamental equations dealing with least and virtual work, and graphic deflection polygons, influence lines, etc., are exhaustively treated in this volume. The author, however, preferred the more circuitous and laborious method of solution.

Although the exact solution of this problem is possible, either by applying the method of (most) "least work" or method of deflections, it would involve as many redundant conditions, x, as there are intersections between horizontal and vertical girders, which, for the author's problem, would have necessitated the solution of $9 \times 16 = 144$ simultaneous equations. Hence, the short cut, of consolidating all material contributing to vertical stiffness into one hypothetical vertical girder, is certainly pardonable. The writer fully indorses this simplification, and adopted it for his own solution, as a practical expedient, but shows how the more exact solution may be accomplished.

As the writer's method, illustrated with a complete problem, is made available to the Profession in his before-mentioned treatise, it is not desired to inflict the burden of repetition on this Society, and hence the reader is invited to consult that treatise for full details.

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* "Kinetic Theory of Engineering Structures", McGraw-Hill Book Co., 1911.

Mr. Molitor. Regarding the solution of simultaneous equations, given in the Appendix to the paper, the writer has made several improvements which greatly reduce the numerical operations, especially the checking, in order to avoid the carrying forward of errors, and, by an appropriate arrangement of the given equations in separate tables, no operations involve more than one sheet at a time. This is also fully explained in his treatise.

The author makes this statement:

> "It seems proper to put on record some of the results obtained, especially as American literature on lock-gates is very scanty. It is believed that the method of calculation used is novel, and is an advance on previous practice."

In view of the facts here presented, such a statement can scarcely be accepted, in so far as it relates to the problem of stress analysis.

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DETENTION RESERVOIRS WITH SPILLWAY OUTLETS AS AN AGENCY IN FLOOD CONTROL

Discussion.*

By Messrs. Ivan E. Houk and Kenneth C. Grant.

Ivan E. Houk,† Assoc. M. Am. Soc. C. E. (by letter).‡—The Engineering Profession is certainly much indebted to the late Gen. Chittenden for this, his last, contribution, as well as for his earlier writings. Mr. Houk.

As a general rule, the only feasible method of utilizing a detention basin for both water power and flood prevention seems to be that suggested by the author, namely, to use the capacity up to a certain elevation for storage purposes and above that elevation for flood prevention. Although cases may occur where automatic control of the part used for flood prevention will not be practicable, such as the one described by Mr. Meyer,§ the writer believes that no other method should be adopted except when absolutely necessary.

The writer does not believe that the design and operation of a detention basin such as proposed by Mr. Petterson,|| would be advisable. Although the paper by Allen Hazen, M. Am. Soc. C. E., on "Storage to be Provided in Impounding Reservoirs for Municipal Water Supply"¶ is to be highly commended, the application of the theory contained therein to the design and operation of a detention reservoir for the purpose of flood prevention, as proposed by Mr. Petterson,

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* Discussion of the paper by the late H. M. Chittenden, M. Am. Soc. C. E., continued from May, 1918, *Proceedings*.

† Dayton, Ohio.

‡ Received by the Secretary, June 14th, 1918.

§ *Proceedings*, Am. Soc. C. E., December, 1917, p. 2467.

|| *Proceedings*, Am. Soc. C. E., May, 1917, p. 687.

¶ *Transactions*, Am. Soc. C. E., Vol. LXXVII (1914), p. 1539.

Mr. Houk. does not seem to be justified. Such a study might be made as a matter of interest in investigating a project where stream-flow records are available for a considerable period, but the conclusion drawn by Mr. Petterson at the end of his discussion, namely, that "the capacity of the composite reservoir, therefore, may be considerably less than the combined volumes of two separate reservoirs, one of which is used for low-water regulation only, and the other is utilized for flood prevention only", as a rule, will not stand the test of application to particular cases.

In the example chosen by Mr. Petterson—the Colorado River at Yuma—most of the floods are caused by melting snows. Consequently, they occur at about the same season. Even in this case, however, it would not seem advisable to assume that the maximum storage will always be required in a certain month. If it should be required a month later than Mr. Petterson has assumed, the total required capacity would be 7 150 000 acre-ft. + 2 660 000 acre-ft., or 99.6% of $F_m + P_m$. The writer has made no mathematical check of Mr. Petterson's work, but a cursory examination of Plate II certainly indicates that the maximum storage for flood prevention would be required in June instead of in May. The writer cannot agree with the statement that "only the month in which the floods commence is of importance". If the capacity reserved for flood prevention is filled during the early part of a flood, the peak may pass over the spillway and cause untold damage. It is the peak of the flood that must be cared for by the reservoir, not the early run-off.

Where the floods are due to rainfall, conditions are quite different from those obtaining on the Colorado, as may be seen from Fig. 11, which shows the daily stages and discharges of the Miami River at Dayton, Ohio, for the past 25 years. There may be, and probably is in most cases, a season in which the maximum floods commonly occur; but that offers no assurance that all maximum floods will occur in that season. The greater number of the floods at Dayton occur in the spring; yet the flood of 1866, which was the second largest in a century, occurred in September. A study such as Mr. Petterson proposes, based on the record shown by Fig. 11, would indicate that practically no storage at all would be required for flood-prevention purposes at Dayton during September. A detention basin operated on that assumption in 1866 would have met disaster.

If we consider the ten-year period, 1907 to 1916, inclusive, and assume that 50% of the mean rate of discharge for that period is used for power, a study based on the data contained in Fig. 11, shows that the maximum capacity for power purposes would have been required in 1914 and that the reservoir should have been full at the end of April. The study also shows that the period of deficient flow began at the end of February in 1915, at the end of March in 1910, Mr. Houk.

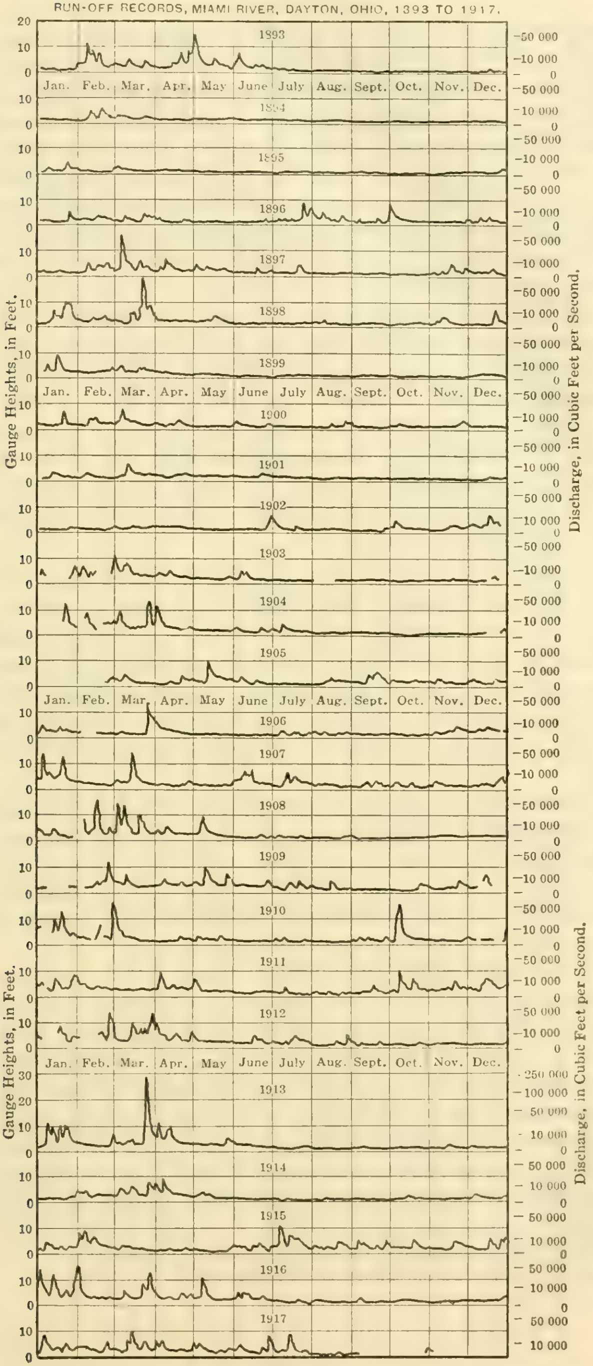

FIG. 11.

Mr. Houk. at the end of April in 1914, at the end of May in 1908 and 1911, at the end of June in 1913 and 1916, and at the end of July in 1907, 1909, and 1912. On the other hand, reservoirs at Dayton for flood-prevention purposes should, by all means, be kept empty during March and April. No water at all should be stored at any time during these months. Consequently, the conditions at Dayton, which the writer does not believe are at all exceptional for this part of the United States, would not permit the construction of a composite reservoir in which the total capacity was less than the total required for flood-prevention purposes plus the total required for storage.

As regards flood prevention and storage for use, the two purposes are antagonistic, and no long study based on the theory of probabilities can prove otherwise. The part of the basin required for flood prevention should be emptied as soon as possible after each flood so that it will be ready for use when the next flood comes. The total space available to store water for use should be kept full at all times. It would not be good business policy to waste water which could be stored because the theory of probabilities showed that more would be available the following month.

Mr. Grant. KENNETH C. GRANT,* M. AM. SOC. C. E. (by letter).†—The discussion of this able paper has doubtless been undertaken with a certain degree of reverence by those who knew the author personally. The writer came to have that honor when the late Gen. Chittenden was engaged on the work of the Miami Conservancy District, and can certainly number himself among those who have this feeling in discussing a subject on which the author was so eminently qualified to set forth his views.

The author has summed up the opinion of competent authorities as to the feasibility of the combined use of a reservoir for flood control and other purposes. He shows that some authorities believe that such a combined use is not feasible, while others believe it is, if storage capacity for each purpose is provided. The author takes his stand with those who hold to the latter opinion.

The writer has studied this subject closely for a number of years and agrees with the author that the same reservoir can be used both for flood control and other purposes. In his opinion, furthermore, a close study of many feasible projects will show that the same reservoir space can be used both for flood control and for other purposes.

In some cases, where there is a well-defined flood season, that part of the capacity set aside for this joint use would be used for flood control during the flood season only. The writer has examined a large reservoir operated in this manner, the Waldeck Reservoir, in Germany.‡

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* Langley Field, Hampton, Va.

† Received by the Secretary, June 22d, 1918.

‡ *Journal*, Engrs.' Soc. of Pennsylvania, May, 1916.

Mr. Grant.

In some other cases, where floods are likely to occur at any time of the year, it would be necessary and feasible to be guided in the use of this dual part of the capacity by a highly developed system of rainfall and stream-gauging stations on the drainage area above the reservoir. To allow the greatest possible time for emptying this flood storage space in advance of the arrival of the flood wave, the manipulation of the gates at the reservoir should be governed by the estimates of inflow based on the rainfall rather than on the stream-gauging reports; but it would be possible and desirable to modify the original plan of manipulation on the basis of stream gaugings. The writer has visited a large reservoir in Germany operated in this manner, the Marklissa Reservoir, in the Province of Silesia.* Fig. 12 shows the flood control effect and operation of this reservoir during a flood in August, 1913.

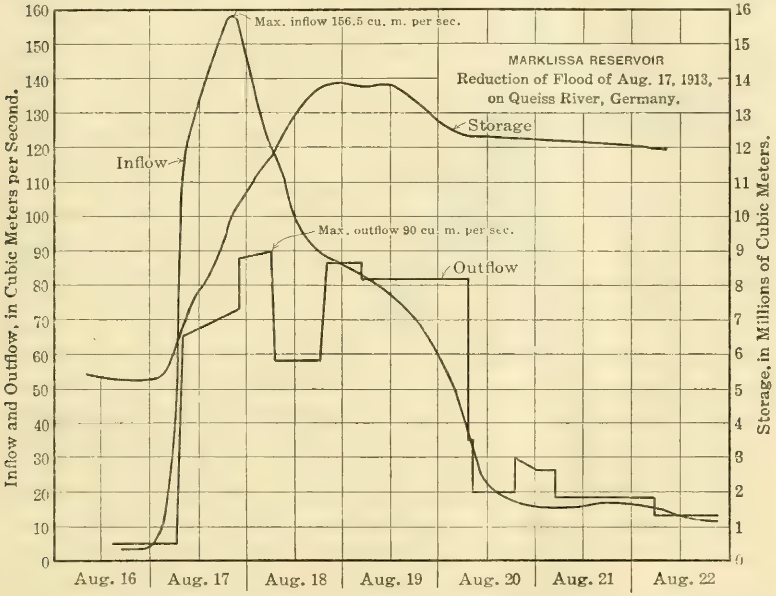

FIG. 12.

Such a combined use of the same storage capacity is especially practicable where two or more reservoirs are located one above the other on the same stream. Errors in prediction which have led to manipulation of the outlets in the reservoir farthest up stream in such a way that the best results have not been obtained, can be corrected at the dams below.

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* *Journal*, Engrs.' Soc. of Pennsylvania, April, 1913.

Mr. Grant. There are many reservoirs in Europe which are used for both flood control and other purposes. Most of them are operated by keeping a certain fixed part of their capacity empty at all times and ready for the storage of damaging flood-water. In practically every case, this flood storage capacity is controlled by gates.

Fig. 13 shows the flood control effect and operation of such a reservoir during a flood in August, 1913. The Mauer Reservoir* is on the Bober River, in the Province of Silesia, Germany. There are several "dry" reservoirs on the drainage area above this reservoir, and their combined flood control effect is indicated by the difference between the estimated maximum inflow, assuming them not to be in operation, 475 cu. m. (16 770 cu. ft.) per sec., and the actual maximum inflow into the Mauer Reservoir, 287 cu. m. (10 130 cu. ft.) per sec., a reduction of 40 per cent.

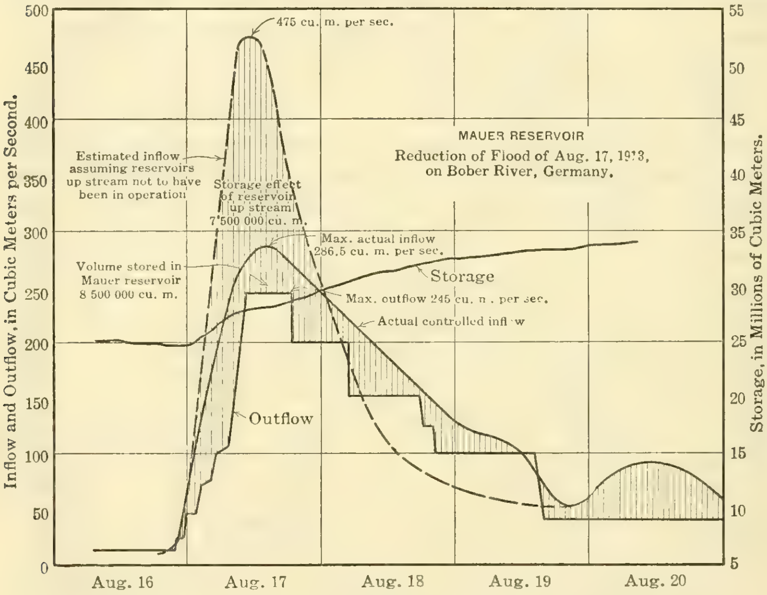

FIG. 13.

In Europe, automatic control, as a rule, is used only in reservoirs built for flood prevention alone, the so-called "dry" reservoirs; though even this type is provided in some cases with mechanical control of the outlets. In most cases, the discharge through the dams of such reservoirs takes place through conduits or tunnels, rather than over spillways, the outlets often being placed at different elevations.

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* *Engineering News*, Vol. 69, p. 672 (April 3d, 1913).

Mr. Grant.

The author, in defining a detention reservoir, states that "the function is purely automatic, human control being wholly eliminated." The writer believes that the type of reservoir described by the author is just as truly a detention reservoir whether the outlets operate automatically or are provided with mechanical means of control.

The writer fully appreciates the arguments in favor of automatic control of storage capacity set aside for flood control, whether in a reservoir used for both flood control and other purposes, or in a "dry" reservoir, particularly the former, where the temptation to encroach on the flood storage capacity may be very strong, and a long period of immunity from great floods may lull those in charge of operations into a false sense of security. He is coming more and more to believe, however, that it is possible to construct and maintain discharging apparatus which can be counted on to operate successfully at all times, and to train and keep on duty reliable operators who will obey orders. It is also believed that the action of those higher up, who give the orders, can be controlled by suitable legislation and competent supervision.

With proper mechanical control of the outlets from a flood control reservoir, a given flood capacity can be operated with considerably greater effectiveness than with automatic control. With mechanical control, at the very start of a flood, water can be released from the reservoir at a rate equal to the carrying capacity of the channel below the dam, and thus less of the storage will be used in storing harmless flood water. Moreover, since any type of flood control reservoir must be designed for maximum flood conditions, it can operate at only part of its maximum efficiency in smaller floods, unless some mechanical means of controlling the outflow is provided.

If automatic control is to be used, the writer would recommend some form of outlet conduits as against the spillway type of outlet, for the same reasons as those very clearly stated by Mr. Morgan in his discussion.* The "ideal control" described by Mr. Morgan, however, can be approached only where some means of controlling the flow through the conduits is provided.

It is only in exceptionally favorable cases that it would be found possible or feasible to control the maximum flood by storage so that the outflow would not exceed the channel capacity below the dam. As a rule, the reservoir control would have to be supplemented by enlarging the channel capacity at points where the value of the property to be protected justified the expense, while other sections would have to remain subject to some overflow in every large flood. With proper mechanical control of the outlets, it would be possible in many cases to prevent overflow of any lands except in maximum or nearly maximum floods, which are of very rare occurrence. From the very basis of design, the available storage capacity of a flood control reservoir with

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* *Proceedings,* Am. Soc. C. E., November, 1917, p. 2012.

Mr. Grant. automatic outlets can operate with maximum effectiveness only in the case of the assumed maximum flood, which may never occur.

It is wisely said by the author that "it is of the first importance that a site once occupied be occupied to the full extent of its possibilities." As he says, "if occupied by an inadequate or inferior work, this may become a permanent bar to the highest development." If the time is not ripe for carrying out all parts of the project, the works should be designed so that additions for the other purposes can be made at a later date. Such a far-sighted utilization of available reservoir sites is possible only if two very essential steps are taken, namely:

(*a*).—The systematic collection and study on an intensive scale, by the proper agencies, of all data necessary for the solution of problems of water conservation and stream control, in order that all uses of the streams may be realized and co-ordinated. Without this information, it will be impossible to determine what the full possibilities of a given reservoir site are.

(*b*).—The framing, passage, and active administration of suitable State and National legislation that will permit and foster co-operation between corporations, municipalities, States, and the Federal Government, in the construction and operation of storage reservoirs for all the various purposes for which they can be used. Without workable legislation of this kind, it will be impossible to bring together the various interests involved in the fullest utilization of our streams, or to compel the complete development of reservoir sites on which projects are proposed.

In connection with the preceding paragraph, the author's remarks regarding "The Human Factor" show a wise appreciation of a very real difficulty, one which will require a broad and thorough education of the public mind to overcome. The problems involved in dealing with this factor in the working out of the Miami Valley project were many and varied, and, at several stages in the proceedings, presented obstacles which gave far more anxiety as to the successful outcome of the plans than any of the engineering problems encountered.*

The solution would seem to be in a Federal law modeled after the Conservancy Law of Ohio. Such laws have been in successful operation for many years in France, Germany, and Austria. In the United States, some of the State drainage and irrigation laws are the same in principle, but are worked out on a much less comprehensive scale.

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* *Journal*, Engrs.' Soc. of Pennsylvania, March, 1914, October, 1915, and November, 1916.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

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VERIFICATION OF THE BAZIN WEIR FORMULA BY HYDRO-CHEMICAL GAUGINGS

Discussion.*

By CLEMENS HERSCHEL, PAST-PRESIDENT, AM. SOC. C. E.

Mr. Herschel.

CLEMENS HERSCHEL,† PAST-PRESIDENT, AM. SOC. C. E. (by letter).‡—With the inclusion of the discussion§ by Frederic P. Stearns, Past-President, Am. Soc. C. E., Mr. Nagler's paper bids fair to become as important a paper on hydraulic engineering, as has appeared in recent volumes of *Transactions*; and the author may conclude that he "has builded wiser than he knew." The very scope and title of the paper, the "verification" of a weir gauging, by a complicated process, such as a hydro-chemical gauging, no doubt caused that old-time fetish of hydraulic engineers—weir gaugings, or the "standard weir"—to totter on its pedestal; while the plain-spoken words of Mr. Stearns: "(1) That in the present state of the art the weir is not an accurate instrument for the measurement of water", and the proofs supplied by the searching analysis that follows, must have caused that old idol to fall irretrievably from the high estate it has occupied in the minds of a numerous body of engineers, lo, these many years.

Under the circumstances, the writer has concluded that it might be of interest to hydraulic engineers were he to extend the remarks he has already made in discussion of Mr. Nagler's paper.‖

If one takes Fig. 26 of Mr. Stearns' discussion, it must be evident, on reflection, that an apparatus of this kind, carrying water which

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* Discussion of the paper by Floyd A. Nagler, Jun. Am. Soc. C. E., continued from May, 1918, *Proceedings*.

† New York City.

‡ Received by the Secretary, July 5th, 1918.

§ *Proceedings*, Am. Soc. C. E., May, 1918, p. 717.

‖ *Proceedings*, Am. Soc. C. E., March, 1918, p. 517.

Mr. Herschel. has a material velocity of approach, cannot cause that water to spill over the crest of the weir with a regular, or devoid-of-turbulence, motion of its particles. The velocity of approach must be changed in direction, upward and "over the top" (to use a prevalent expression of the day). If, as in truth, this velocity of approach is only the resultant in one direction of turbulent motion in all sorts of directions, but prevailing toward the weir, then such turbulence will necessarily be increased in the angle between the up-stream face of the weir and the bottom of the flume. The elements of turbulent motion are largely accidental, and hence do not lend themselves to determinations of precision.

Again, why the seemingly excruciating process of dragging the particles of water across the sharp edge of a metal right-angled corner of a bar of iron; which torture the water resists, and it protests and squirms, until it jumps upward and "over the top", in defiance of its own inclinations and the laws of gravity, so that it is forced to form a little hollow next down stream from the weir crest?

The question may be answered categorically by pointing out that 200 years ago, or more, when hydraulic experiments were in their infancy, the idea of a discharge over or through a "thin plate" was adopted, for the sake of uniformity in practice—a definition of a member that could be easily stated, and the member could then be readily reproduced. Apart from this, however, it has no special value.

Suppose, instead, that we were to make a weir crest—to be adopted as the standard weir crest—semicircular in cross-section, and of some adopted standard radius of generation, say, 2.5 cm., if one likes—near enough to 1 in. to be called an inch, in the present instance; again, if one pleases, tangentially joining a solid curve of transition that shall fill the angle between the up-stream face of the weir and the bottom of the flume, somewhat following the line marked "Limit of Angle of Pressure" in Fig. 26, and, of course, to be defined in terms, to become normal (a catenary or a parabola); or a straight line, on a 2:1 slope, because it is readily constructed of wood. Would not the flow over such a weir be smoother, cleaner, less excruciating to behold or imagine? Would it not give more concordant results, and a smaller range of coefficients?

Next, let us consider the matter of observing the head on the weir. If the discharge were out of a tank, or reservoir, there would be, commonly speaking, no velocity of approach; and, to observe the height of still water up stream from the weir, and let it rule in the formula for discharge, would be a simple matter. This was the original condition of things, when weir experiments and experiments on the discharge of orifices were first made; when the apparatus for such experiments were mere playthings; but a weir without end contractions, near the down-stream end of a 6½ or 8-ft. flume, is quite another affair. To

Mr. Herschel.

observe the depth on the weir in such cases, as has been generally done hitherto, is a mixing up of the study of hydrostatics and hydraulics, which long ago called forth the protest of the writer.

This was done by an article* entitled "The New Hydraulics" ("The New Hydrometry", would have been a better title), some extracts from which may now be reproduced in this discussion:

> "To the graduate student or practitioner in hydraulics [hydrometry] of the present day, there has always been something disappointing in the art. Here is a science which pretends to give rules and formulæ for the discharge of water through orifices and over weirs, when in truth it only indicates what these rules should be, and are not. Instead of being a science founded on fact, and deduced theory, as it set out to be, it has degenerated into a prolix schedule of coefficients to be applied in hydraulic cases as they are met with. So numerous have these coefficients become, that their great number has defeated their very purpose. It has been found impossible to match cases as they arise, with their appurtenant coefficients, and engineers have been obliged to practically ignore the most of them, and, instead of using them, to confine themselves in their practice to a very few selected simple cases. Instead of practicing under the guidance of a science of hydraulics, the working hydraulician takes for his mentors only a few simple hydraulic experiments, and by repeating with slavish exactness the apparatus used in the experiments to be followed, he manages merely to allow nature to do for him what she did years before for another. Any step, therefore, that will do away with or merely will reduce the range of the multitude of coefficients now found recorded in hydraulic writings for the practice of hydraulics, will benefit that science very much.
>
> "Hydraulics, to look at the situation from another point of view, has not hitherto been able to free itself from the apron-strings of its older sister science of hydrostatics. Instead of noting the conditions obtaining strictly for the water in motion which is to be observed, and confining himself to them alone, the modern hydraulician still encumbers his work with measurements based on, or derived from, a water level which belongs in the domain of the hydrostatics of the case in hand, rather than in that of its hydraulics. Such cases are the measurement of the head on a weir, by measuring from the level of still [actually: running] water upstream from the weir; and determining the head on an orifice, from the position of the orifice and the level of still water upstream from it. Inasmuch as this mode of procedure totally eliminates the form and shape of the weir or orifice —takes no account of the same whatever—the measurements thus taken being precisely the same for any and all kinds of weirs and orifices; and inasmuch as these different kinds of orifices do have, nevertheless, very different unit discharges, it becomes necessary to introduce a host of coefficients to cause this method of procedure to produce the numerous called for practical results.
>
> "But how would it be, were we in these cases to take measurements and observations which would themselves be influenced by the shapes

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* *Engineering News,* November 10th, 1898.

Mr. Herschel. of the orifices and by the velocity of the water passing through them? May we not hope, that the coefficients to be applied to formulæ containing data thus obtained, would have a much smaller range and would be much reduced in number, to the manifest benefit of the art and science now spoken of? * * *

"A method of doing hydraulic work in the manner alluded to must be the next great step to take in the development of practical hydraulics, and there are many signs of the times, plain enough to those who will see them, that point in the stated direction."

Bazin has left us a significant proposition in this line. On page 238 of his final essay in the *Annales des Ponts et Chaussées,* 1898, the last section of the essay and at the very end of the account of all his weir experiments, which occupied his time for 50 years,* he says:

"*Pressure Under the Sheet of Water (Nappe) and Distribution of Velocity in Its Interior.*—The pressure under the nappe was measured in nearly all the experiments; as also, for a certain number of them, the distribution of pressures and velocities in their interior. This distribution has a theoretical value; but not so in the case of the pressure under the nappe, which in certain cases may be utilized. Given a weir of a certain type, its coefficient, *m*, will depend principally on two elements, namely: the contraction at the crest, and the pressure under the nappe; this pressure being so closely dependent on the discharge, that, by observing it continuously, one could deduce from it the variations of discharge with a precision which cannot be obtained by measuring the head on the weir directly.* * *"

Bazin then goes on to show, mathematically, that the method proposed is applicable to weirs of all kinds and forms of construction:

"The measure of pressure can thus be utilized to register variable discharges. An instrument founded on that manner of procedure has been in use in America for some years to meter the discharge of large conduits. It is well known, following some experiments of Venturi, that if one constricts on a short length of conduit, its diameter, a diminution of pressure is produced, corresponding to the produced increase of velocity. Determining now, by suitable rating, the relation that exists between these two elements, it is plain that a measure of pressures will lead to a measure of discharges, and that by automatic registration, one obtains the discharge of the conduit during a stated time, in spite of variations of flow. On this principle is founded the apparatus devised by Mr. Clemens Herschel.† The same principle is evidently applicable to weirs, and one could even cause them to register their discharge automatically, by using the apparatus described by Engineer Hegly to translate a record of head into a record of discharge. A measure of pressures under the nappe, showing with greater sensitiveness than a measure of head, all the variations in the régime of the falling nappe, may thus render useful service in certain especial cases where great precision may be necessary." Mr. Herschel.

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* Bazin's experiments on weirs are only imperfectly known in the United States. As usually quoted, they are referred to as found in the translation by Marichal and Trautwine of his article in *Annales des Ponts et Chaussées,* of 1888, II. The complete list of these articles is as follows: 1888, II; 1890, I; 1891, II; 1894, I; 1896, II; 1898, II.

† *Transactions,* Am. Soc. Civ. Engrs., Vol. XVIII (1888).

To resume quotations from the writer's article, previously mentioned:

"By taking heights on the weir, as measured by means of a pressure tube laid in the body of the crest of the weir [see page 217 of Bazin's article, 1898] and basing the formulæ for the discharge of weirs on such hydraulic heights, instead of on heights derived from still water, which may be called hydrostatic heights, he [Bazin] gets again, as in the experiments above recited, a much smaller range of coefficients for his formulæ. M. l'inspecteur general Bazin notes with pleasure that this mode of observation and record gives more accurate results than the hydrostatic method, and is to be followed by preference.

"Nothing is wanting, then, to enable engineers to use the method of hydraulic coefficients exclusively, except an advocacy and teaching of the practice and a collection of the new coefficients, derived from experiment."

No such work has been done, however, in the 20 years that have passed since these words were written. To some this may be a source of discouragement, or even a reflection on the cogency or validity of the suggestion made. Let one consider, however, that change and invention, in despite of all boasting on the subject, move but slowly. Engineers are fettered by the forces of inertia quite as much as other people. Old-time habits, the teachings of school books, the constraining influences of ruts and channels of thought, control them only too rigidly, or else we should long ago have seen an improvement made in the practice of hydrometry, such as has been here advocated.

Bazin, after spending the better part of a lifetime on hydraulic experimenting, leaves such advocacy as his last words to the Profession. The writer did not hesitate, 20 years ago, to argue to the same end, and 20 years of further experience has only served to confirm him in those views.

Passing now to proof that the hydraulic system of pressure observations in hydrometry, and smooth running water, lead to a small range of coefficients in the appurtenant formulas, let us consider an instrument for metering water, other liquids, and gases, that makes use of those elements of hydrometry, referring, as many readers will have at once recognized, to the Venturi meter.

As an advisory member of the Power Test Committee of the American Society of Mechanical Engineers, the writer has recently had the duty imposed on him of compiling the coefficients that have been found by experimenters during the some 30 years' life of the Venturi meter. These coefficients are presented in Table 7.

Explanation of Table 7.—Column 1 gives the size of the end diameters and of the throat of the meter tube; also, the nature of the test

Mr. Herschel.

TABLE 7.—VENTURI METER COEFFICIENTS.

American Society of Mechanical Engineers, Power Test Committee.

(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)		(9)		(10)
Velocity through the throat, in feet per second.		5		10		20		30		40		50		60		Average.		Remarks.
		Meter.	Tube.	Meter.	Tube.	Meter.	Tube.	Meter.	Tube.	Meter.	Tube.	Meter.	Tube.	Meter.	Tube.	Meter.	Tube.	
1 by 0.33 ft., Tank test, Herschel	Coefficient Loss of head		(0.940) 0.06		0.987 0.26		0.995 0.97		0.999 2.10		(1.000)							Made of hooped wood.
1 by 0.5 ft., Tank test, Cornell Univ	Coefficient Loss of head		0.984		0.987		0.991		0.987		0.983						0.987	Cast iron.
1 by 0.43 ft., Tank test. Cornell Univ	Coefficient Loss of head		0.983 0.06		0.990 0.25		0.997 0.95		1.000 2.10		0.996 (3.30)						0.993	Cast iron.
by 0.33 ft., Tank test, Cornell Univ	Coefficient Loss of head		0.989		0.985		0.987		0.990		0.993		0.989		1.000		0.988	Cast iron.
2 by 1 ft., Weir Compn., Holyoke Water Power	Coefficient Loss of head	0.99	0.99	0.99	0.99													Cast iron.
2.5 by 1.08 ft., Tank test, F. H. Shaw	Coefficient Loss of head			1.00		1.00	The average of 44 tests, during a period of 7 years; extremes were +1.10 and −1.89%.											Cast iron.
4 by 1.33 ft., Weir Compn., Herschel	Coefficient Loss of head		1.00 0.03		0.995 0.15		0.986 0.62		(0.978) (1.44)									Wood; inside riveted plate.
8 by 4 ft., Tank test. Pittsburgh Water Works	Coefficient Loss of head			1.00														Riveted plate.
9 by 3 ft. Weir Compn., Herschel	Coefficient Loss of head		(0.994) 0.04		0.986 0.18		0.978 0.77		0.968 1.54									Wood; inside riveted plate.

Mr. Herschel.

or experiment, whether volumetric (in a tank) or by comparison with a weir, and the authority for the statements made.

Column 2 refers, respectively, to the coefficients to be applied to the theoretical discharge of the Venturi tube, or of the complete Venturi meter, to attain the discharge with which it has been compared, whether tank measurement or weir. In the latter case, it does not follow that either the coefficient given, or the weir discharge from which this coefficient has been derived, is correct.

There is also given, when it has been observed, the loss of head, in feet of water column, end to end of the meter tube.

Both coefficients and losses of head are entered as appurtenant to the velocities of water through the throat of the meter tube, in feet per second, as given in the top main horizontal row.

Columns 3 to 9 give, alternately, the coefficients and losses of head, just mentioned, according as they have been found for the complete Venturi meter, or for the meter tube only, the latter requiring an observer, notebook, and pencil, and computation or diagram, to result in knowledge of the quantity of water discharged.

Column 10 states the construction of the meter tube. It is to be understood, however, that the throat of the meter and a short section at the up-stream end are invariably made of, or lined with, bronze.

Comment appears unnecessary. Attention, however, should be called to one other feature of the general art of making measurements, revealed by the experience at Lancaster, Pa., with the Venturi meter, with tank tests, made by F. H. Shaw, M. Am. Soc. C. E., during a period of seven years. Though the average of 44 such tests differs from unity by only $\frac{1}{28}$ of 1%, yet the two extreme variations were + 1.10 and — 1.89 per cent.

Why should there be any variations as wide as this from the true average?

To ask this question, is to answer it. There is probably no simpler operation in engineering than the measurement of the length of a base line. Yet every engineer knows that, were he to measure it a thousand times, no two of the measurements would be precisely the same, except by chance, even when made by the same implements; and occasional measurements would vary materially from the true average.

The reason lies in the imperfections of human nature and abilities, in the "personal equation" and such similar defects, and not in the apparatus or method used.

Arrived at the close of this discussion, we can sum up our conclusions, by sketching how weir and orifice measurements may be made

Mr. Herschel. more accurate in practice and with a smaller range of discharge coefficients:

(1). Adopt, if possible by international agreement, a standard cross-section of the orifice edges, or weir crest other than a thin plate. This may be a semicircle, as has been suggested, of 2.5-cm. (1-in.) radius, being the outside surface of a 2-in. pipe, or pipe of some such diameter, in which may be fashioned the piezometer holes to transmit pressure.*

(2). Make the standard weir with a gentle channel of approach, up stream from and below the weir crest, as advocated in the beginning of this discussion.

(3). Make a series of experiments on the discharge through such orifices, and over such weirs. With the number of hydraulic laboratories happily already in being, this ought not to be a difficult matter, especially, if this experimental work were apportioned among them.

(4). Set up formulas and tables of coefficients to represent the results of these 20th Century hydraulic experiments.

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* Bazin used a small tube, of about 0.6-in. outer, and 0.2-in. inner, diameter, to receive the pressure from under the nappe and convey it to the measuring instrument; but this tube was laid in the body of the weir and did not constitute the crest of the weir, as is now proposed.

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THE ECONOMICS OF STEEL ARCH BRIDGES

Discussion.*

By Messrs. T. Kennard Thomson, Charles Evan Fowler, W. B. Farr, and Horatio P. Van Cleve.

Mr. Thomson.

T. Kennard Thomson,† M. Am. Soc. C. E.—The author deserves the thanks of the Profession for the immense labor of love he has performed in making these calculations and giving engineers the benefit of the results.

No one recognizes better than Dr. Waddell the fact that environment and special features of topography and scenery will often control the ratio of rise to span of the arch to be built, rather than the quantity of steel in the structure.

For instance, the speaker's design, Fig. 24, for a three-hinged steel arch bridge encased in concrete, to cross the Niagara River just below the Falls, has a rise of only 0.13, as compared with the author's figures of 0.20 to 0.38. In other words, the rise of this bridge will only be about 110 ft. for a span of 840 ft.

If the design were changed to give a rise of 0.25, then its height would be 210 ft., or 100 ft. higher; and in that case the floor would have to be raised 100 ft., if the deck-bridge design is to be retained, or the sides or trusses would have to extend 100 ft. or more above the floor. Neither of these changes should be allowed, in this case, as the

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* Discussion of the paper by J. A. L. Waddell, M. Am. Soc. C. E., continued from May, 1918, *Proceedings*.

† New York City.

Mr. Thomson. bridge should not be so unduly conspicuous—especially in the neighborhood of the Falls; and, besides, the excess of concrete used would probably counterbalance the saving in the steel. The design as it stands is arranged to give the least possible obstruction to the view of the Falls, and has the appearance of naturally filling its proper location between the cliffs. In other words, any well-designed engineering structure will look as if it were put there by Nature, and, like a well-dressed man, will not cause a question regarding its *raison d'être*.

While speaking on the subject of economy of design the opportunity might be taken to refer to a detail of economy which applies to nearly all steel bridges, whether arches or not, but which, unfortunately, often seems to be neglected, although it is very important. It is the comparison between the efficient and excess weight of steel in a bridge. By the efficient weight is meant the weight of the plates or shapes which go to make up the necessary section to withstand the stresses. By the excess weight is meant all other steel, such as pin-plates, splice-plates, lattice-bars, pins, bolts, rivets, etc. Naturally, economy requires that the excess weights be kept as small as good design will permit.

On a small bridge, of course, there is not so much leeway as on a large one; but, for very large members, within which a painter can work, a box or circular column or strut would often be more economical than the usual web systems which are held together by lattice-bars, diaphragms, etc. When the bridge is built under a "pound price", however, there is a temptation to use the heavier sections, especially as they can be handled more easily in the shop.

The first essential in designing a column would be to make it equally strong in any direction; but this is difficult to accomplish economically when it is built up of several heavy ribs connected by latticing, etc. An economical light column can be secured by riveting an I-beam between two channels, giving a section having very little excess. This permits painting, which a small box-column does not. Where the sections are large enough to permit a man to pass through, a box or circular section would be more easily protected against rust, and the saving in weight should overbalance the increase in cost of labor.

If this rule—equal strength in any direction—had been followed in the design of the first Quebec Bridge, the disaster at that site would probably never have occurred.

The speaker knows that it would be presumptuous to try to teach Dr. Waddell anything about bridge design, but he trusts that he will be pardoned for inserting these self-evident, but often needed, remarks, for the benefit of students of bridge building.

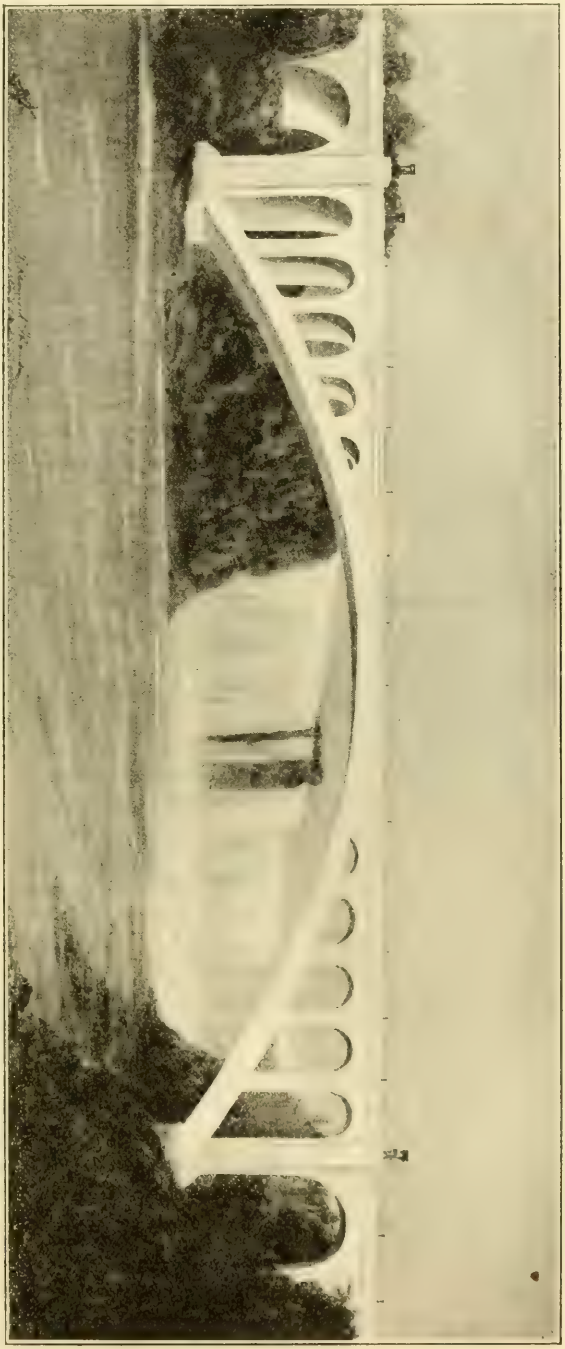

FIG. 24.—PROPOSED BRIDGE OVER THE NIAGARA RIVER NEAR THE FALLS. THREE-HINGED STEEL ARCH, ENCASED IN CONCRETE. MAIN SPAN, 840 FEET; HEIGHT ABOVE RIVER, 143 FEET.

Mr. Fowler.

Charles Evan Fowler,* M. Am. Soc. C. E.—The great amount of detail work involved in such a paper as this is not fully realized unless one attempts a thorough investigation of the subject. The Profession is much indebted to the author for making this systematic study of arches and for recording the results of such an extensive series of calculations. An independent examination of the subject reveals almost as wide a divergence from the author's views as there are modifications of each class of structure.

The speaker has always believed the arch to be a splendid type of structure to "fill up a hole" or fit into a given gorge, with but little latitude for deck spans to influence true economy, if one adheres to esthetics in the best sense. This seems to be borne out by a study of the one hundred arches in Table 8, Plate III, ranging in span from slightly less than 200 to nearly 3 000 ft. That is, such is the general conclusion with regard to deck spans, but, of course, through or half-through arches can always be designed with a real regard for economy.

The fundamental idea to be borne in mind, however, is that, even though many deck arches cannot be designed with the most economic depth, and consequently are not economical structures when considered alone, the total cost of the structure, including foundations, will usually be much less than that of a bridge of any other class, where there are rocky walls or a rock foundation to take up the thrust, and with slight expense for preparing the skewbacks.

Although only one hundred arches of more than 200 ft. span have been found and listed, twenty-four of which have not been actually built, arches of shorter span are probably more numerous than bridges of any other type, except perhaps simple trusses; and if stone, concrete, and reinforced concrete arch bridges are included, the number is legion. The case under consideration has to do with steel or framed arches, and the study of the list referred to has been undertaken on the assumption that each designer has had a reasonable regard for all theoretical and practical considerations, and has selected the most economical type of arch and the best theoretical proportions for it, when not hampered by unalterable conditions. The more the various structures and designs are studied, the more certain is it that there are many flagrant departures from economy, especially in the case of the shorter spans, which do not warrant a great expenditure for investigating independently the economic possibilities. The speaker has always endeavored in special cases to make such investigations, but has always believed that the economic rise was practically equivalent to the depth of a simple truss span. In other words, given a certain type of arch, the rise must be selected as nearly as possible in the same way that the depth of a truss is found, that is, deeper for the heavier and dynamic loadings. Where one-sixth rise might prove

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* New York City.

Mr. Fowler. enough for producing a stiff structure for the light loading of a highway arch bridge, it would need to be increased to one-fifth, or perhaps to one-fourth, or more, for heavier loading and for railways, using the engineer's judgment for preliminary layouts to form the basis for investigations. This, therefore, does not agree fully with the author's findings. Judgment alone would have indicated that the Washington Bridge over the Harlem should have had a greater rise than 18% if in any way possible, or, the girders should have been deeper, and thus have avoided in large measure the vibration or bouncing of the structure caused by the live loads. The rise necessary to overcome this would have been much greater than the economical rise found by the author, or probably 25% of the span, or greater. The same unpleasant feature occurred in the speaker's Knoxville arched cantilever, and in both cases it is largely due to the inertia of a heavy paved floor, a condition which cannot be entirely overcome. The ultimate limit of economy should not be considered as the only thing to attain; the aim should be to design a structure that shall be stiffer and therefore more lasting, without, of course, any undue increase in cost. The Alexander III Bridge, in Paris, is an even more flagrant example of a too shallow arch, and, with a rise of only one-seventeenth, the vibration, of course, is as predominant as it is lacking in arches of possibly too great rise, like the speaker's White Pass, Alaska arch, with a rise 37.5% of the span, or the St. Croix, Minn., arch spans, with 35.5% rise.

The discussion of the subject can be taken up more understandingly by considering at this point the various types of arches that have been built (or designed), as shown by the list (Table 8, Plate III) prepared by the speaker. This list is believed to be several times more extensive than any previously compiled. The data have been checked from the original sources, as far as can be found in the Engineering Societies Library, and many errors have been corrected in data which have been in current use for some years. The various types were found to be as follows:

(*a*).—Arch ribs with no hinges, plate girders;
(*b*).—Arch ribs with no hinges, lattice ribs;
(*c*).—Arch ribs with no hinges, trussed ribs;
(*d*).—Arch ribs with one center hinge, plate girders;
(*e*).—Arch with one center hinge, spandrel-braced;
(*f*).—Arch with two hinges, plate-girder ribs;
(*g*).—Arch with two hinges, lattice ribs;
(*h*).—Arch with two hinges, trussed ribs;
(*i*).—Arch with two hinges, spandrel-braced;
(*j*).—Arch with three hinges, plate-girder ribs;
(*k*).—Arch with three hinges, lattice ribs;

TABLE 8.—ONE HUNDRED STEEL ARCH BRIDGES, FROM 200 TO 3 000 FEET SPAN.

No.	Location.	Span, in feet.	Rise, in feet.	L ÷ R	R ÷ L	Waddell percentage.	RIB DEPTH, IN FEET.			Kind of traffic.		Class.	No. Hinges.	Remarks.	Engineer.	Date built or designed.	Reference.
				Proportion.	Percentage.		Center.	Springing.	Percentage.								
1	Hudson River, New York City§	2 850.0	440.0	6.5	15.5	30.0	100.0	....	3.5	H.-T.	Hy. & Ry.	Lat. Rib.	2	Longest arch ever designed. Bold erection plan.	Max am Ende.	1889§	*The Engineer*, May, 1889.
2	Quebec, Canada§	1 800.0	164.0	11.0	9.1	25.0	21.0	42.0	1.2	D.	Ry.	Spand. Br.	1	Voussoir arch. Thrust resisted by concrete struts.	Worthington.	1910§	*Engineering News*, May, 1910.
3	Forth, Scotland§	1 650.0	330.0	5.0	20.0	30.0	71.0	....	4.3	H.-T.	Ry.	Par. Lat. Rib.	3	Comparison of 3-hinged parabolic rib with cantilever.	Max am Ende.	1888§	*The Engineer*, May, 1888.
4	" " §	1 640.0	395.0	4.2	24.0	30.0	20.0	50.0	1.2	H.-T.	Ry.	Lat. Rib.	0	Very shallow, no-hinge lattice rib with internal truss.	" " "	1890§	*Engineering*, Feb., 1890.
5	Quebec, Canada§	1 600.0	320.0	5.0	20.0	30.0	69.0	....	4.3	H.-T.	Ry.	Par. Lat. Rib.	3	Investigation of 3-hinged parabolic rib for this site.	" " "	1898§	*The Engineer*, May, 1898.
6	Sydney, New South Wales§	1 600.0	320.0	5.0	20.0	30.0	69.0	....	4.3	H.-T.	Hy.	Par. Lat. Rib.	3	Investigation of 3-hinged parabolic rib. Valuable.	" " "	1893§	" " "
7	Bosphorus, Turkey§	1 240.0	240.0	5.2	19.3	30.0	53.0	....	4.3	H.-T.	Ry.	Par. Lat. Rib.	3	Comparison of 3-hinged parabolic rib with other bridges.	" " "	1893§	" " "
8	Thames, London, England§	1 152.0	270.0	4.3	23.5	30.0	55.0	....	4.8	H.-T.	Hy.	Par. Lat. Rib.	3	3-hinged parabolic rib. Novel scheme below Tower Bridge.	" " "	1892§	*The Engineer*, March, 1892.
9	Hell Gate, New York City	977.5	220.0	4.4	22.5	30.0	40.2	140.0	4.1	H.-T.	Ry.	Truss Rib.	2	Longest arch built. Economical and artistic.	Lindenthal.	1916	*Proc.*, Am. Soc. C. E., Oct., 1917.
10	" " " " " §	977.5	235.0	4.2	24.0	30.0	60.0	....	6.1	D.	Ry.	Lat. Rib.	2	Study of 2-hinged crescent arch for No. 9 location.	"	1905§	*Proc.*, Am. Soc. C. E., Oct., 1917.
11	Kentucky River§	864.0	162.5	5.3	18.8	23.3	49.3	....	5.7	D.	Hy.	Lat. Rib.	2	2-hinged crescent arch to replace High Bridge.	"	1907§	*Engineering Record*, Nov. 26, 1910.
12	Harlem River, New York City§	850.0	130.0	6.5	15.3	25.0	28.0	102.0	3.3	D.	Hy.	Spand. Br.	3	Longest spandrel-braced span ever designed.	Hodge.	1907§	Waddell, Br. Engr.
13	Niagara, N. Y.	840.0	150.0	5.6	17.8	30.0	26.0	....	3.1	D.	Hy.	Lat. Rib.	2	Longest 2-hinged lattice rib ever built. Very light.	R. S. Buck.	1898	*Engineering Record*, 1898-9.
14	" " §	840.0	110.0	7.6	13.1	22.5	20.0	30.0	2.4	D.	Hy.	Lat. Rib.	3	Designed to replace No. 13; to be covered with concrete.	Thomson.	1918§	
15	Viaur, France	722.0	176.2	4.1	24.4	25.0	11.0	33.0	1.4	D.	Ry.	Cant. Sp. Br.	3	Longest cantilever arch ever constructed.	Bodin.	1898	*Engineering News*, 1900-2.
16	Vilaine, France	626.9	150.0	4.2	23.9	33.0	4.4	33.2	0.7	H.-T.	Hy.	Lat. Rib.*	0	Novel combination, 0-hinge and 3-hinge. Erection striking	Lebert.	1912	*Le Génie Civil*, Nov., 1912.
17	Bonn, Germany	614.0	97.0	6.4	15.8	30.0	15.7	34.6	2.6	T.	Hy.	Truss Rib.	2	Braced rib with tension tie. Very artistic.	Krohn.	1899	*Engineering News*, 1899-1.
18	Duesseldorf, Germany	594.7	90.5	6.6	15.2	30.0	15.7	31.6	2.7	T.	Hy.	Truss Rib.	2	Similar in design to No. 17 at Bonn.	"	1899	*Engineering News*, 1899-1.
19	Needles, Cal.	592.0	100.0	5.9	17.2	30.0	18.5	....	3.1	H.-T.	Hy.	Lat. Rib.	3	Lightest and longest 3-hinge lattice rib built.	Sourwine.	1916	*Engineering Record*, Nov. 11, 1916.
20	Cleveland, Ohio	591.0	144.0	4.1	24.3	30.0	20.0	91.2	3.4	2 D.	Hy.	Truss Rib.	3	Similar in outline to Hell Gate Arch (No. 9).	Felgate.	1916	*Engineering News*, June 18, 1914.
21	Luiz I, Douro, Portugal	566.0	146.4	4.0	26.0	33.0	26.2	55.0	4.7	D.	Hy.	Lat. Rib.	0	Carries two roadways, at low and high level.	Seyrig.	1886	Mehrtens.
22	" " " §	566.0	155.0	3.7	27.4	28.0	Av. 26.0	A. 40.0	4.6	2 D.	Hy.	Lat. Rib.	0	Comparative design, from original competition.	Handyside.	1880§	*Engineering*, Dec. 24, 1880.
23	" " " §	566.0	155.0	3.7	27.4	22.5	18.0	....	3.2	2 D.	Hy.	Lat. Rib.	2	Comparative design, 2-hinge lattice rib.	Eiffel.	1880§	" " " "
24	" " " §	566.0	145.0	3.9	25.6	22.5	26.0	....	4.6	2 D.	Hy.	Lat. Rib.	2	Comparative design, 2-hinge lattice rib.	Cail.	1880§	" " " "
25	" " " §	566.0	151.7	3.8	26.8	28.0	26.3	39.3	4.6	2 D.	Hy.	Lat. Rib.	0	Comparative design, 0-hinge lattice rib.	Seyrig.	1880§	" " " "
26	St. John, N. B., Canada	560.0	60.0	9.3	10.7	25.0	8.5	60.0	1.5	D.	Hy.	Spand. Br.	2	Lowest rise for long-span spandrel arch.	Schneider.	1916	Kunz.
27	Niagara, M. C. Ry§	560.0	132.0	4.2	23.5	25.0	30.0	....	5.3	D.	Ry.	Spand. Br.	2	Well-proportioned arch to replace cantilever.	Deimling.	1912§	*Engineering News*.
28	Mungsten, Germany	557.8	241.0	2.3	43.2	28.0	9.9	39.4	1.8	D.	Ry.	Lat. Rib.	0	Highest rise, 0 hinge arch in the world.	Rieppel.	1897	*Engineering News*, 1898-2.
29	Niagara, G. T. Ry	550.0	114.0	4.9	20.7	25.0	20.0	....	3.6	D.	Ry.	Spand. Br.	2	Erected as cantilever while using suspension.	L. L. Buck.	1897	*Engineering News*, 1896-2.
30	Washington, New York City§	543.0	90.0	6.0	16.5	23.0	18.0	....	3.3	D.	Hy.	Lat. Rib.	0	Longest of designs submitted in competition.	Buck.	1887§	*Engineering News*, Dec. 27, 1890.
31	Garabit, France	541.3	183.6	2.9	33.9	33.0	32.2	....	6.0	D.	Ry.	Lat. Rib.	2	Most striking design of 2-hinge deck lattice rib.	Bauby.	1885	*Engineering News*, 1884-5.
32	Rockingham, Vt.	540.0	90.0	6.0	16.7	30.0	14.0	....	2.6	H.-T.	Hy.	Lat. Rib.	3	Best example of light 3-hinge through lattice rib.	Worcester.	1905	*Engineering Record*, Nov., 1904.
33	Washington, New York City§	540.0	90.0	6.0	16.7	22.5	16.0	....	3.0	D.	Hy.	Lat. Rib.	2	Design received second prize in competition.	Hildenbrand.	1887§	*Engineering News*, Dec. 27, 1890.
34	Levensau, Germany	533.0	69.5	7.7	13.0	30.0	10.5	18.4	2.0	H.-T.	Ry.	Lat. Rib.	2	Kiel Canal Arch, of comparatively small rise.	Lauter.	1892	*Engineering*, Aug. 16, 1895.
35	Tonkin, China	532.7	82.0	6.5	15.4	30.0	9.7	29.8	1.8	H.-T.	Hy. & Ry.	Lat. Rib.	3	Remarkable 3-hinge through lattice rib with tie.	Dayde.	1909	*Le Génie Civil*, May 8, 1909.
36	Pia Maria, Douro, Portugal	525.0	139.5	3.8	26.6	33.0	32.8	....	6.3	D.	Ry.	Lat. Rib.	2	Very bold deck. 2-hinge lattice rib of good rise.	Seyrig.	1877	Mehrtens.
37	Kamerun, South Africa	523.6	65.6	8.1	12.5	25.0	16.3	32.9	3.1	D.	Ry.	Spand. Br.	2	One of two striking arches built in Africa.	Muellenhoff.	1912	*Engineering News*, Dec. 26, 1912.
38	St. Louis, Mo.	520.0	47.5	11.1	9.1	23.0	12.0	....	2.3	D.	Hy. & Ry.	Lat. Rib.	0	Pioneer of long steel arches. Small rise and rib depth.	Eads.	1874	*Engineering News*, 1877.
39	Gruenenthal, Germany	513.3	77.3	6.7	15.0	30.0	13.5	....	2.5	H.-T.	Hy. & Ry.	Lat. Rib.	2	Kiel Canal. Second of great arches over Canal.	Eggert and Greve.	1892	*Engineering*, Aug., 1895.
40	Washington, New York City	510.0	91.7	5.6	18.0	20.0	13.0	....	2.6	D.	Hy.	Pl. Gir.	2	Design built. With rise used, ribs should be deeper.	Hutton.	1889	*Engineering News*, June, 1887.
41	St. Louis, Mo.	502.0	46.0	11.1	9.1	23.0	12.0	....	2.4	D.	Hy. & Ry.	Lat. Rib.	0	Side spans of No. 38. Erection scheme notable.	Eads.	1874	*Engineering News*, 1877.
42	Zambesi, Africa	500.0	90.0	5.6	18.0	25.0	15.0	105.0	3.0	D.	Ry.	Spand. Br.	2	Second in length in Africa. At Zambesi Falls.	Douglas.	1905	*Railway Gazette*, 1906.
43	Paderno, Italy	492.0	122.3	4.0	24.9	25.0	23.0	....	4.7	D.	Hy. & Ry.	Truss Rib.	0	Well-designed, with good rise and rib depth.	Rothlisberger.	1889	*Engineering Record*, Oct., 1888.
44	Austerlitz, Paris	460.0	65.6	7.0	14.3	30.0	7.0	....	1.5	H.-T.	Ry.	Lat. Rib.†	3	3-hinged, fixed-end arch. Type applicable to No. 61.	Lavallois.	1905	*Engineering News*, Dec., 1906.
45	Washington, New York City§	456.0	80.0	5.7	17.5	22.5	20.0	....	4.4	D.	Hy.	Lat. Rib.	0	First prize design. Better than design used.	Schneider.	1887§	*Engineering News*, Dec. 27, 1890.
46	Minneapolis, Minn.	456.0	90.0	5.0	19.7	25.0	6.0	96.0	1.3	D.	Hy.	Spand. Br.	3	Proportions very fair for 3-hinged, spandrel-braced.	Sewall.	1888	*Engineering Record*, May, 1908.
47	Rio Grande, Costa Rica	448.7	56.0	8.0	12.5	25.0	12.6	63.5	2.8	D.	Ry.	Cant. Sp. Br.	2	Good design of 2-hinged cantilever arch type.	Cooper and Aus.	1902	*Engineering News*, Oct., 1902.
48	Oakland, Pittsburgh, Pa.	440.0	75.0	5.9	17.0	23.0	10.0	14.0	2.3	D.	Hy.	Truss Rib.	0	0-hinged truss rib of shallow rise and rib depth.	Brunner.	1907	*Engineering News*, 1907-1.
49	Frazer River, Canada	425.0	90.0	4.7	21.2	25.0	20.0	120.0	4.7	D.	Ry.	Spand. Br.	3	Good proportions. Built by Waddell, 1915.	Waddell.	1915	Waddell, Br. Engr.
50	Genesee River, N. Y.	416.0	67.0	6.2	16.1	25.0	12.0	79.0	2.9	D.	Hy.	Spand. Br.	3	Early type of 3-hinged, spandrel-braced arch.	L. L. Buck.	1890	*Engineering Record*, Aug., 1891.
51	Richmond, Ind.	400.0	40.0	10.0	10.0	25.0	10.7	....	2.7	D.	Hy.	Spand. Br.	3	Lightest arch built. Very small rise and rib depth.	Doran.	1896	*Engineering News*, June 22, 1899.
52	Mayence, Germany	384.0	69.3	5.5	18.1	22.5	13.2	53.9	3.4	H.-T.	Hy.	Lat. Rib.	2	Through 2-hinged rib with tie. Of good proportions.	Nurnberg Works.	1904	*The Engineer*, Nov. 11, 1904.
53	Worms, Germany	383.3	57.5	6.7	15.0	30.0	9.6	37.7	2.5	T.	Hy.	Truss Rib.	2	Same type as No. 52, but proportions not so good.	Freutzen.	1900	*Engineering Record*, Sept., 1901.
54	Kornhaus, Berne	377.0	103.0	3.7	27.4	28.0	5.3	13.8	1.4	D.	Hy.	Lat. Rib.	0	0-hinged, lattice-rib, deck arch. Small rib depth.	Arthur and Fisher.	1898	*Engineering News*, 1897-2.
55	Schwarzwasser, Berne	373.0	70.0	5.4	18.7	28.0	17.0	23.3	4.5	D.	Hy.	Lat. Rib.	0	Similar to No. 54, but of much better proportions.	Rothlisberger.	1882	*Engineering News*, 1897-2.
56	Vilaine, France	367.4	49.2	7.5	13.4	30.0	4.4	....	1.2	T.	Hy.	Lat. Rib.*	3	3-hinged portion of No. 16 acting as separate arch.	Lebert.	1912	*Le Génie Civil*, Nov., 1912.
57	Ft. Snelling, Minn.	364.0	74.5	4.9	20.5	25.0	10.0	34.5	2.8	D.	Hy.	Spand. Br.	3	3-hinged, spandrel-braced arch of good proportions.	Shuck.	1909	*Engineering Record*, June, 1909.
58	Szegedin, Hungary	361.1	28.0	12.9	7.8	25.0	9.0	....	2.5	D.	Hy.	Spand. Br.	3	Early example of spandrel arch: poor proportions.	Feketehazy.	1884	*Ann. des Ponts et Chaussees*, 1892.
59	Hondu, Colombia, South America	360.0	52.0	7.0	14.4	25.0	2.0	54.0	0.6	D.	Hy. & Ry.	Cant. Sp. Br.	3	Cantilever arch; special type. Longest in South America.	Bender.	1884	Bender, p. 189.
60	Panther Hollow, Pittsburgh, Pa.	360.0	45.0	8.0	12.5	25.0	4.8	49.5	1.3	D.	Hy.	Spand. Br.	2	2-hinged, spandrel-braced. Too small rise and rib depth.	Schultz.	1896	*Engineering Record*, June, 1896.
61	Alexander III, Paris	352.6	20.6	17.0	5.9	20.0	5.0	....	1.4	D.	Hy.	Cast-Steel Gir.	3	Cast-steel voussoirs. More rise possible. See type No. 44.	Resal.	1899	*Engineering News*, April, 1898.
62	Metz, Germany	351.0	31.2	11.3	8.9	22.5	16.4	....	4.7	D.	Hy.	Lat. Rib.	2	Very shallow 2-hinged deck arch. Good rib depth.	Altenloh.	1878	Mehrtens.
63	St. Croix, Minn.	350.0	124.0	2.8	35.5	25.0	25.0	....	7.2	D.	Hy.	Spand. Br.	3	Spandrel arch of greatest rise. Large center depth.	Turner.	1910	*Engineering News*, 1910.
64	Coblenz, Germany	348.0	28.3	12.3	8.1	22.5	16.4	....	4.7	D.	Hy.	Lat. Rib.	2	2-hinged lattice rib, small rise. Illustrated in Mehrtens.	Hilf.	1879	Mehrtens, p. 216.
65	Worms, Germany	345.0	36.5	9.5	10.6	30.0	6.9	....	2.0	T.	Hy.	Lat. Rib.	2	Type of through arch common in Germany.	Freutzen.	1900	*The Engineer*, Vol. 98, p. 86.
66	Mayence, Germany	341.0	32.8	10.4	9.6	22.5	6.3	....	1.9	D.	Hy.	Lat. Rib.	2	Deck 2-hinged lattice rib. Small rise and rib depth.	Nurnberg Works.	1903	*Bauzeitung*, 1903.
67	Crooked River, Ore.	340.0	60.0	5.7	17.6	25.0	12.0	....	3.5	D.	Ry.	Spand. Br.	2	Erected cantilever over gorge. Very good proportions.	Modjeski.	1912	*Engineering News*, March 20, 1912.
68	Hamilton, New Zealand	340.0	42.0	8.1	12.4	20.0	7.0	....	2.1	D.	Ry.	Pl. Gir.	3	3-hinged, plate-girder ribs of proper depth. Small rise.	Waddell.	1907	Waddell, Br. Engr.
69	Stony Creek, Canada	337.0	80.5	4.2	23.8	22.5	20.2	30.2	6.0	D.	Hy.	Lat. Rib.	2	2-hinged lattice rib of usual steel bridge details.	Peterson.	1893	*Engineering News*, Aug., 1894.
70	Mayence, Germany§	336.9	32.8	10.2	9.7	20.0	4.9	....	1.5	D.	Hy.	Pl. Gir.	2	Competitive plan. Very shallow, 2-hinged, plate-girder arch.	Krieche.	1881§	*Engineering*, July 29, 1881.
71	" " §	334.0	32.3	10.3	9.7	23.0	6.3	8.2	1.9	D.	Hy.	Lat. Rib.	0	Competitive plan. Very shallow, 0-hinged, lattice-rib arch.	Lauter.	1881§	" " " "
72	" " §	328.1	32.8	10.0	10.0	22.5	5.8	A. 6.6	1.8	D.	Hy.	Lat. Rib.	2	Competitive plan. Striking 2-hinged sickle arch.	Ritgen.	1881§	" " " "
73	Mirabeau, Paris	326.0	20.3	16.1	6.2	25.0	2.8	18.0	0.9	D.	Hy.	Cant. Sp. Br.	3	Cantilever arch. Very small rise and rib depth.	Resal.	1896	*Engineering News*, Nov. 12, 1896.
74	Coblenz, Germany	316.0	31.5	10.1	9.9	22.5	16.1	....	5.1	H.-T.	Ry.	Lat. Rib.	2	Half-through arch. Very small rise. Good rib depth.	Hartwich.	1866	Mehrtens, p. 194.
75	Bonn, Germany	307.0	31.0	9.9	10.1	25.0	4.0	....	1.3	D.	Hy.	Spand. Br.	3	End spans of No. 17. 3-hinged, spandrel-braced; very shallow.	Krohn.	1899	*Engineering News*, 1899-1.
76	Verona, Italy	291.3	32.8	8.9	11.2	25.0	4.6	....	1.6	H.-T.	Hy.	Lat. Rib.	2	Remarkably small rise and rib depth; 2-hinged lattice.	Biadego.	1894	*Engineering*, April 17, 1895.
77	Surprise Creek, Canada	290.3	90.0	3.2	31.0	25.0	16.0	65.0	5.5	D.	Ry.	Spand. Br.	2	2-hinged, spandrel-braced arch of good proportions	Peterson.	1898	*Engineering Record*, July, 1898.
78	Cambridge, New Zealand	290.0	52.0	5.6	18.0	25.0	17.3	69.3	6.0	D.	Hy.	Spand. Br.	3	3-hinged, spandrel-braced. Small rise. Large center depth.	Waddell.	1905	*The Engineer*.
79	Arcole, France	262.5	20.2	13.0	7.7	25.0	1.3	4.6	0.5	D.	Hy.	Pl. Gir.	0	Very flat arch. Shallow rib. Reinforced in 1888.	Oudry.	1855	*Engineering News*, 1888-1.
80	Minneapolis, Minn.	258.0	25.0	10.0	10.1	20.0	5.0	....	1.9	D.	Hy.	Pl. Gir.	3	3-hinged, plate-girder deck arch. Very shallow.	Strobel.	1890	*Engineering Record*, May, 1890.
81	Spokane, Wash.	255.0	33.9	7.5	13.3	25.0	8.5	48.4	3.4	D.	Ry.	Spand. Br.	3	3-hinged combination span. Small rise.	Fowler.	1904	*Proc.*, Pac. N. W. Soc. Engrs.
82	Knoxville, Tenn.	242.0	30.0	8.0	12.5	25.0	20.0	....	8.2	D.	Hy.	Arch Cant.	2	Arched cantilever. Small rise. Large center depth.	Fowler.	1896	*Engineering News*, 1896-1.
83	White Pass, Alaska	240.0	90.4	2.7	37.5	33.0	0.0	....	0.0	D.	Ry.	Spand. Br.	3	3-hinged rafter, spandrel braced arch. Erected cantilever.	Fowler and Wood.	1901	*Engineering News*, 1901.
84	Salem, Ore.§	240.0	41.0	5.8	17.1	22.5	5.5	8.8	2.3	T.	Hy.	Lat. Rib.	3	3-hinged circular arch, lattice rib with tie.	Fowler.	1914§	Fowler.
85	Angora, Turkey	236.0	64.5	3.7	27.3	33.0	9.8	....	4.2	D.	Ry.	Lat. Rib.	3	3-hinged lattice rib changed from 2-hinged after service.	Baehr.	1908	*Engineering News*, Aug. 25, 1910.
86	Blauw-Krantz, South Africa	229.6	93.5	2.5	40.9	33.0	9.8	....	4.3	D.	Ry.	Lat. Rib.‡	0	0-hinged rectangular arch erected as cantilever.	Max am Ende	1884	Mehrtens, p. 664.
87	Moraud, France	221.1	14.0	15.8	6.3	22.5	2.6	8.8	1.2	D.	Hy.	2-H. D. L. Pl. Gir.	0	0-hinged, plate-girder. Erected as 2 hinged. Extremely shallow.	Tavernier.	1889	*Engineering*, Nov. 4, 1898.
88	Youngstown, Ohio	210.0	60.0	3.5	28.5	28.0	8.0	....	3.8	D.	Hy.	Pl. Gir.	2	2-hinged, plate-girder rib. Good rise and rib depth.	Fowler.	1898	*Engineering Record*, 1899-1.
89	" " §	210.0	60.0	3.5	28.5	25.0	8.6	....	4.1	D.	Hy.	Arch Cant.	2	2-hinged, arched cantilever. More costly than No. 88.	Fowler.	1896§	Fowler.
90	Iron Mountain, Mich.	207.0	52.0	4.0	25.1	25.0	11.0	41.0	5.3	D.	Ry.	Spand. Br.	3	Excellent proportions for 3-hinged, spandrel braced arch.	Loweth.	1903	*Engineering News*, Nov., 1902.
91	Fairmount Park, Philadelphia, Pa.	200.0	40.0	5.0	20.0	25.0	4.8	44.8	2.4	D.	Hy. & Ry.	Spand. Br.	3	Four-span, 3-hinged, spandrel-braced. Good proportions.	Deans.	1898	*Engineering News*, Aug., 1898.
92	Croton Dam, N. Y.	200.0	43.5	4.6	21.8	22.5	3.0	....	1.5	D.	Hy.	Pl. Gir.	1	Only example of 1-hinged rib. Rib depth too small.	Lucius.	1904	*Engineering News*, Dec., 1904.
93	St. Guistiana, Austria	196.8	36.7	5.3	18.6	25.0	4.9	38.9	2.5	D.	Hy.	Spand. Br.	2	2-hinged, spandrel-braced arch. Fairly good proportions.	Hagen.	1889	*Engineering News*, 1890-1.
94	Fern Hollow, Pittsburgh, Pa.	195.0	59.0	3.3	30.4	33.0	6.5	....	3.3	D.	Hy.	Pl. Gir.	3	3-hinged, plate girder rib. Good rise and rib depth.	Brunner.	1909	*Engineering News*, 1908-1.
95	Woodstock, Vt.	193.6	45.0	4.3	23.3	20.0	6.6	....	3.4	D.	Ry.	Pl. Gir.	3	Excellent proportions. Estimated weight 12½% over sp. br.	Hovey.	1911	American Bridge Co.
96	Assopos, Greece	193.5	75.8	2.6	39.1	22.5	5.3	A. 28.0	2.7	D.	Ry.	Lat. Rib.‡	3	3-hinged, lattice rib. Deeper at quarter points of rib.	Bodin.	1909	*Engineering News*, Nov. 4, 1909.
97	Woodstock, Vt.	187.9	48.0	3.9	25.6	25.0	7.0	55.0	3.8	D.	Ry.	Spand. Br.	3	3-hinged, spandrel braced instead of No. 95. Novel cantilever erection.	Hovey.	1911	American Bridge Co.
98	Nanti Gorge, China	180.0	51.2	3.5	28.5	33.0	0.0	....	0.0	D.	Hy.	Tr. Rafter.	3	3-hinged truss rafters. Erected in vertical position and lowered.	Soc. C. deB.	1909	*Engineering News*, April 21, 1910.
99	Cerveyrette Gorge, France	172.2	37.7	4.6	22.0	23.0	2.5	9.8	1.5	D.	Hy.	Lat. Rib.	0	0-hinged lattice rib of good rise. Very shallow rib.	Baldy.	1892	*Engineering News*, 1892-2.
100	Manhattan Drive, New York City	163.5	34.3	4.8	21.0	22.5	6.0	....	3.6	D.	Hy.	Lat. Rib.	2	Well-proportioned 2 hinged, lattice-rib arch.	New York City.	1908	*Engineering News*, 1908.

*Three-hinged, fixed end. †Fixed end. ‡Square arch. §Designed, but not built. A. = Quarter point. L. = Span. R. = Rise. D. = Deck. T. = Through. H.-T. = Half through. Hy. = Highway. Ry. = Railway.

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(*l*).—Arch with three hinges, trussed ribs;
(*m*).—Arch with three hinges, spandrel-braced;
(*n*).—Arch with three hinges, and fixed ends;
(*o*).—Arch with three hinges, no center depth;
(*p*).—Arch with five hinges, spandrel-braced;
(*q*).—Cantilever arches, three hinges;
(*r*).—Arched cantilevers, two hinges.

These eighteen types, of course, are only modifications of five basic types: no hinges, one hinge, two hinges, three hinges, and cantilever arches. The investigation as to the last word in economy for a given crossing, therefore, may prove to be an almost endless task, unless the engineer, from long experience, can single out two or three types which are quite sure to prove suitable. The chance of making an error therefore, would seem greater in the selection of the type, than the possibility of serious error in proportions.

It is the speaker's opinion that the economic depth can be varied 5% either way, without much exceeding the computer's most probable percentage of error in making an estimate from a stress sheet, and the variation of sectional area, which may easily total 5 per cent. This is undoubtedly borne out by a study of the author's diagrams.

The list of one hundred arches has been studied by tabulating the ratio of rise to span, as well as the depth of the ribs or arch, and an average result thus determined, which, in a great measure, is valuable as a composite of the investigation into these important features.

Plate-Girder Rib With No Hinges.—The average for the two arches of this type is only 7.2% of the span length for rise, or a ratio of $L \div R$ of 13.8; which, of course, is too shallow, and less than half the rise recommended by the speaker in Table 9. The average depth of rib at the center is only 0.9% of the span length, or about one-third of the minimum advised. In fact, the Arcole Arch, in Paris (No. 79), failed under modern traffic and had to be reinforced.

Lattice Rib With No Hinges.—The average of seventeen arches of this type is 22.6% of the span length for rise, or a ratio of $L \div R$ of 4.4; or, discarding three distinct violations of economy, 25.4%, or a ratio of 3.9, which latter value, however, is only about three-fourths of the author's average. The average percentage of L for depth of rib is 3.0, but, discarding six cases where the depth is manifestly too small, the average is 3.8, or only practically one-half the value given by the author.

Plate-Girder Rib With One Hinge.—There is only one example of this type, and it agrees closely with the author's values; the percentage of rise to span length is 21.8, or a ratio of $L \div R$ of 4.6;

Mr. Fowler. the percentage of L for depth of rib is only 1.5, which is undoubtedly much too low, even for a plate girder.

Spandrel-Braced Arch With One Hinge.—There is only one example of this type, the design for an 1 800-ft. voussoir arch span at Quebec, and the possible rise is too low for a deck arch. The percentage of span length for rise is only 9.1, or a ratio of $L \div R$ of practically 11.0; the percentage of L for center depth is only 1.2. The location was certainly more suitable for a half-through arch of the type shown in Fig. 25, (No. 5 in Table 8, Plate III), and described later for this same crossing.

Plate-Girder Arch With Two Hinges.—There are three examples of this type, and the average percentage of rise to span is 18.7, or a ratio of 5.3; but, discarding the very shallow arch, No. 70, the average is 23.3%, or a ratio of $L \div R$ of 4.3; the average percentage of L for depth of rib is 3.2, and the maximum is only 3.8.

Lattice-Rib Arch With Two Hinges.—The average for twenty-five arches is 17.1% of the span length for rise, or a ratio of $L \div R$ of 5.8; but, discarding seven distinct violations of economy, 20.0% or a ratio of 5.0; the first slightly low value is accounted for by the seven deck arches included, of only about one-tenth rise; the average percentage of L for depth of rib is only 3.8; but, if five of the largest values are excluded, the result would be only 3.2. The average of those omitted, however, is only 6.0%, and the maximum value is 6.3%, as compared with the 7.5% recommended by the author.

Spandrel-Braced Arch With Two Hinges.—The average of the twelve cases of this type is 17.1% of the span length for rise, or a ratio of $L \div R$ of 5.8; which value is perhaps slightly too low for economy, but is accounted for by a number of deck arches with insufficient distance below grade to allow for a greater rise; the average values found by discarding the very flat arches, are 18.5% and a ratio of 5.4. The average percentage of L for center depth is 3.4, with no normal value in excess of 5.5.

Plate-Girder Rib-Arch With Three Hinges.—There are only six examples of this type, and the average percentage of rise to span length is 18.6, or a ratio of $L \div R$ of 5.4; or, discarding the two very flat arches, 23.6%, or a ratio of 4.2. The average percentage of L for depth of rib is 2.8, or, discarding the two abnormal cases, 3.3 either value being high enough for plate-girder ribs.

Lattice-Rib Arch With Three Hinges.—The average for fifteen arches is 20.2% of the span length for rise, or a ratio of $L \div R$ of 4.9; and, as the highest value is 27.3%, or a ratio of 3.7, this type would seem to agree more closely with the author's results. The average percentage of L for depth of rib is 3.6, for rational cases, or practically one-half the author's value; and the maximum value is only 4.8 per cent.

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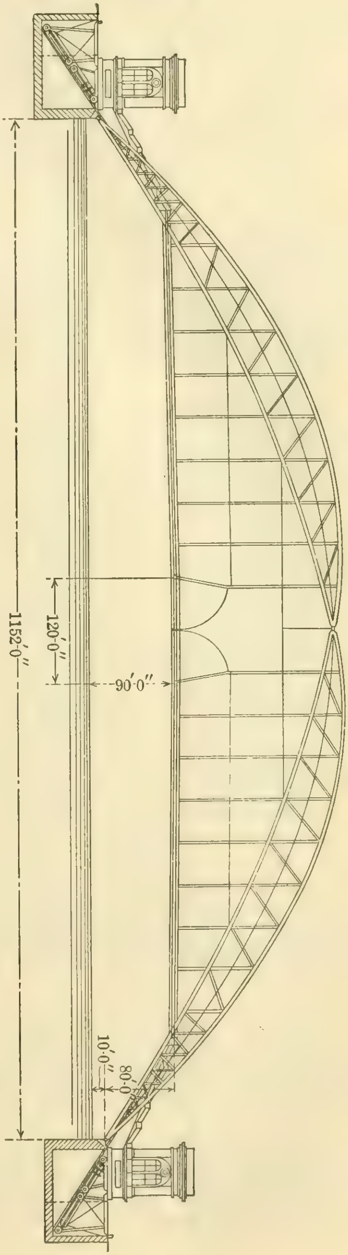
Spandrel-Braced Arch With Three Hinges.—The average for eighteen arches is 19.7% of the span length for rise, or a ratio of $L \div R$ of 5.1, which is only slightly less than the values recommended by the speaker in Table 9, but considerably less than those recommended by the author. The foregoing average value includes one high-deck arch in which the percentage is 35.5 and the ratio 2.8, which is the only really high-deck spandrel arch (No. 63) found recorded. The average percentage of L for center depth is 3.2, and 7.2 for the high-deck spandrel arch (No. 63).

Spandrel-Braced Cantilever Arch, Five Hinges.—The one design described in this discussion has a span of 1 670 ft. and a rise of 272 ft. The rise is 16.3% of the span, or a ratio of $L \div R$ of 6.1; the center depth is 2.1% of the span length.

The average for the one hundred cases is 18.9% of span for rise, or a ratio of $L \div R$ of 5.3; the average of the author for the same cases would be 26.6 per cent. The average for the one hundred cases (18.9%) indicates how much too low is the one-seventh or 14.2% general value given by Kunz; and that the author's values are too high, especially when applied to light highway and lighter railway arches.



PROPOSED SINGLE SPAN OPENING BRIDGE FOR THE LOWER THAMES.

Fig. 25.

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TABLE 9.—ARCH BRIDGE RISE AND RIB.

Type.	WADDELL'S RATIOS.			EXISTING ARCHES.			FOWLER'S RATIOS.†		
	Light highway *	Railway. Heavy highway.	Center and rib.	Light highway.	Railway. Heavy highway.	Center and rib.	Light highway.	Railway. Heavy highway.	Center and rib.
0-Hinge, deck.									
Plate girder	22.5	25.0	....	(2) 7.2	....	0.9	17.5	20.0	2.5
Lattice rib	25.0	28.0	7.5	(1) 22.0	(7) 20.4	3.6	20.0	22.5	3.5
0-Hinge, high deck.									
Plate girder	30.0	33.0	....	....	....	....	20.0	25.0	3.0
Lattice rib	35.0	38.0	7.5	....	(5) 33.0	3.4	25.0	35.0	3.5
0-Hinge, through.									
Lattice rib	30.0	33.0	7.5	(1) 23.5	(2) 24.0	1.0	22.5	25.0	3.5
1-Hinge, deck.									
Plate girder	20.0	22.5	....	(1) 21.8	....	1.5	17.5	22.5	3 0
Spandrel-braced	22.5	25.0	7.5	....	(1) 9.1	1.2	20.0	25.0	4.0
2-Hinge, deck.									
Plate girder	17.5	20.0	....	....	(2) 23.3	3.2	20.0	25.0	3.5
Lattice rib	20.0	22.5	7.5	(2) 18.6	(7) 20.6	3.8	22.5	28.0	4.0
Spandrel-braced	22.5	25.0	7.5	(3) 13.1	(10) 18.5	3.4	17.5	22.5	4.0
2-Hinge, high deck.									
Plate girder	22.5 25.0	25.0 28.0	....	....	....	....	.... 25.0	.... 33.0	.... 3.0
Lattice rib	30.0 35.0	33.0 38.0	.... 7.5	....	.... (2) 30.9	.... 4.6	.... 38.0	.... 45.0	.... 4.0
-Hinge, through.									
Plate girder	20.0	22.5	....	....	....	....	17.5	20.0	3.5
Lattice rib	27.5	30.0	7.5	(2) 15.7	(9) 17.1	3.2	20.0	22.5	4.0
3-Hinge, deck.									
Plate girder	17.5	20.0	....	(2) 17.5	(4) 23.6	3.3	20.0	22.5	3.3
Lattice rib	20.0	22.5	7.5	....	(2) 20.2	3.3	22.5	25.0	4.0
Spandrel-braced	22.5	25.0	7.5	(2) 17.1	(15) 22.0	3.2	20.0	22.5	5.0
3-Hinge, high deck.									
Plate girder	22.5 25.0	25.0 28.0	....	......	(1) 30.4	3.3	25.0	35.0	3.0
Lattice rib	30.0 35.0	33.0 38.0	.... 7.5	......	(2) 33.8	3.0	33.0	40.0	4.0
Spandrel-braced	....	....	....	(1) 35.5	....	7.2	30.0	35.0	6.0
3-Hinge, through									
Plate girder	20.0	22.5	....	....	....	....	17.5	20.0	3.5
Lattice rib	27.5	30.0	7.5	(3) 15.8	(8) 18.7	3.7	20.0	22.5	4.3

* First column = Waddell less 2½%, his allowable variation.

† The ratios in the last three columns are those recommended, based on a study of existing arches, Waddell's ratios, and ratios in ordinary use, giving the minimum rise for deck arches and the maximum for high deck and through arches. Not based on three middle columns. Figures in parentheses refer to the number of normal cases averaged.

The average value of depth of rib for the one hundred arches is 3.2%, as compared with 7.5% of the span length recommended by the author; and indicates that the values given by the speaker in Table 9 are more logical, or a safe basis for investigations, as it will give a rib depth great enough for rational designing as well as economy. Mr. Hovey's investigations for the plate-girder arch ribs of No. 95 bear out the author's deductions for plate-girder ribs, as given in Table 9.

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The Hell Gate Bridge proportions were fixed after a very careful investigation and analysis, and it is stated* by O. H. Ammann, M. Am. Soc. C. E., that:

> "The weight of an arch of this type and length varies inappreciably for variations in rise between one-sixth and one-fourth of the span [or 8.3% range in rise], the absolute minimum being probably nearer the lower value [16.7%].
>
> * * * * * * *
>
> "The height of the trusses was decreased toward the center to 40 ft. 2⅝ in., or approximately one-twenty-fourth of the span length [4.1%], so as to reduce the temperature stresses, which are greatest at the center. The height of 140 ft. at the ends of the trusses was determined by the necessity for rigid portals between the end posts above the track floor. These assumptions for height resulted in the slightly reversed curve of the top chord, which produces a very pleasing sky line."

The speaker agrees with this last statement, and believes, also, that the proportions of this structure are scientific and perfectly logical.

The data by Kunz as to the proportions of steel arches are worth quoting, but are too general to be of great value. The ratio of rise to span is stated to range ordinarily from one-fourth to one-twelfth with possible extreme values of from one-half to one-fifteenth; and with an average for economy of one-seventh. (This the speaker has pointed out as being too flat, except possibly for very light highway bridges.) Kunz states that the center depth should range from one-sixtieth to one-fifteenth (or 1.7 to 6.6%), and he recommends for two-hinged, spandrel-braced arches, with parallel chords, from one-twenty-fifth to one-twentieth (or from 4.0 to 5.0%, which accords with the speaker's views); crescent ribs from one-eighteenth to one-fifteenth (or from 5.6 to 6.7%, which the speaker has pointed out to be very extreme values); with spandrel-braced arches, where the height is limited, the center depth may be as small as one-fortieth (2.5%), but the center panels should have solid webs. The foregoing may be reduced from 25 to 40% for highway bridges. Kunz also states that the depth of plate-girder ribs should be from one-sixtieth to one-fortieth (from 1.7 to 2.5%, which are certainly minimum values); and that the suspended span of cantilever arches should be from one-half to five-eighths of the side span.

Conclusions.—The conclusions reached by the speaker, from the foregoing average values, the author's values, and a study of the individual designs in detail, are that the following conditions should be observed:

Where the possible rise below grade would make the arch too flat for rigidity, as in numerous cases listed, notably the Alexander III

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* In his paper entitled "The Hell Gate Arch Bridge and Approaches of the New York Connecting Railroad Over the East River in New York City", *Proceedings*, Am. Soc. C. E., October, 1917.

Mr. Fowler. Bridge, the Washington Bridge, the St. John Bridge in Canada, and the design for an 1 800-ft. arch at Quebec by Worthington, then a half-through type of arch would be preferable. Although the vibrations from the live load are not all due to the small rise, as has been shown in truss spans of extra depth built by the speaker, where the bouncing could only be attributed to the inertia of a heavy paved floor, the greater rise recommended is certainly advisable.

Where there is a greater depth below grade, than is required for economical rise, the economy of the structure is but little changed by making the rise proportionately great, leaving no more, in any case, than room above the crown of the arch for a distributing truss, if it is to be used, and not carrying the roadway directly by long posts, which are unsightly when they extend above the top of the arch rib. The designers of the Viaur, Cleveland, Luiz I, Mungsten, Garabit, Pia Maria, Kornhaus, St. Croix, White Pass, Blauw-Krantz, Youngstown, Fern Hollow, Namti, and Surprise Creek Arches evidently found this method of design most artistic, and fairly economical, or they would not have used such proportions. The speaker has in mind no actual cases which would indicate a contrary view.

Wherever possible the rise should be greater than indicated by theory or ordinary practice, especially in the case of railway arches or those for heavy highway loads, and it is found that twenty-four of the arches in Table 8, Plate III, have a rise of practically 25.0% or greater, and eight of these have a rise greater than 30.0 per cent. The study of individual cases indicates that the depth should seldom be less than 20.0%, and should preferably be 25.0% or greater, in the interests of stiffness and consequently longer life of the structures carrying the heavier loadings.

Where the best bridge is desired, that is, the one with the greatest ultimate economy, and not the cheapest in first cost, it will usually be found economical, and more artistic with a deck structure, to build it with a rise greater than 25.0%, and often up to 40.0% or greater, when there is room below grade; or even for a half-through arch when it would not prove to be top heavy.

Where the possible rise is materially less than 17.0% for heavy loading, some other type than a deck arch should be used, or the idea of an arch should be abandoned and a structure of an entirely different type designed.

The depth of rib, or center depth, as recommended by the author, would seem to be excessive; and, for arch ribs, the center or quarter depth should only be from 3.0 to 4.0% of the span length, except in the case of solid ribs, where the depth might be as small as 2.5%, but never less than 2.0%, unless for some unavoidable reason, and greater than 2.5% for spans of small rise.

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The end depth of ribs without hinges, of course, must be greater than at the center or crown, as required by the stresses, but, for appearances, never less than one and one-half times the center depth, and usually not less than two and one-half times. The greatest ratio is four times, as in the great Mungsten, no-hinge, lattice-rib.

The center depth of spandrel-braced arches has varied all the way from 0.0 to 8.5%, but a depth of about 4.0% would seem to be economical and artistic, and a depth as great as 7.0 or 8.0% would often be decidedly displeasing.

The center depth of three-hinged ribs is perhaps more pleasing when not less than the greatest depth of the rib, but such a design is not the most economical, as will be shown later.

The center hinge in a spandrel-braced arch has been placed almost always in the lower chord, and this is a much better location, especially with respect to detailing the structure.

The list, Table 8, Plate III, in which 74% of the structures are deck arches, and which is as complete as the data in the Engineering Societies Library afford, shows that for steel arches from about 200 ft. to 3 000 ft. span, there have been designed and built of the no-hinge type 19.0%; of the one-hinge type 2.0%; of the two-hinge type 40.0%; of the three-hinge type 39.0%; and, of all these, 71% have been of the arch-rib type and only 29% of the spandrel-braced type.

Therefore it might be concluded that designers have found the arch rib much more economical as well as more artistic than the spandrel-braced arch, and the types with no hinges and one hinge less economical than those with two and three hinges, although this quite certainly has been due, to some extent, to an unwarranted prejudice against wholly statically indeterminate structures. The practical economy of the two-hinged and three-hinged types may, from the tabulation and other published data, be considered as equal.

The findings of M. A. Howe, M. Am. Soc. C. E., as to the no-hinge type being the most economical, and the two-hinge type next in economy, agrees with the speaker's experience; and, as to the relative economy of the two-hinged and three-hinged types, this is borne out by the author and by the investigations* of C. W. Hudson, M. Am. Soc. C. E., the arches being of the spandrel-braced type, of 20.0% rise and 3.0% center depth, having a span of 200 ft., and designed for a paved highway. The weight of the two-hinged arch was found to be 109 000 lb. and of the three-hinged arch 115 000 lb., or a saving of 5.5% in favor of the two-hinged structure. H. S. Jacoby, Assoc. Am. Soc. C. E., gives a comparison† of two-hinged and three-hinged designs for the 550-ft. Niagara Arch, and states that the three-

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* *Transactions*, Am. Soc. C. E., Vol. XLIII, p. 20.

† Discussion of Mr. Hudson's paper in *Transactions*, Am. Soc. C. E., Vol. XLIII, p. 31.

Mr. Fowler. hinged arch showed a saving of only 0.84% over the two-hinged type. The investigation of an arch, three-hinged for dead load and two-hinged for live load, showed 4.2% greater weight than the regular two-hinged type.

The speaker's investigations for this discussion have convinced him that the three-hinged, parabolic, lattice-rib arch, as shown in Fig. 25, is the most economical type of any given in Table 8, Plate III, and it is certainly worth investigating for any long and important span. Table 8 gives the economical proportions for an arch of this type, for Nos. 3, 5, 6, 7, and 8. It indicates that the economical rise for heavy loads is from 19.3 to 23.5% of the span length, and the economical maximum depth of the rib as only from 4.3 to 4.8% of the span length, although the exact depth of rib is automatically determined for each case by the calculations. The development of this type was due to Mr. Max am Ende, the English engineer who designed the Blauw-Krantz Arch, South Africa (No. 86). The type was evidently first proposed in 1892 for the Thames River at London, just below the Tower Bridge.* The outline of the arch ribs is of most interest in this discussion, but the general scheme of this 1 152-ft. arch span is worthy of brief description. The roadway has a clearance of 90 ft. above the water and 80 ft. above the grade on shore, this difference of elevation being overcome by platforms operated on inclined tracks to elevate vehicle traffic to the level of the bridge roadway. All ordinary vessels could pass under the roadway, but, for vessels with tall masts or funnels, the double bascule opening of 120 ft. is provided. As the theory of this parabolic arch-rib structure has been fully developed† space will not be taken here, except to explain that the top flange of each half rib has the form of the curve of pressures for that half loaded, and the bottom flange has the form of the curve of pressures for that half unloaded; thus both flanges are normally always in compression. All will remember the old bowstring truss, also the King and Massillon Arches, each of which closely approximated the outline of the moment curve, and was theoretically of the lightest weight for a simple span. Engineers still endeavor to make truss outlines, for economy, conform as closely as possible to the form of the curves of moments, and, therefore, it is not surprising that this parabolic rib arch should prove economical. It is in reality the Fidler truss for a suspension bridge reversed. Mr. am Ende has also proposed a suspension bridge of this type for the Straits of Messina, of 3 280-ft. span, which, as far as the speaker knows, is the longest span of any kind that any one has had the temerity to propose seriously. Among the designs listed in Table 8, Plate III, is one for the Firth of Forth of two 1 650-ft. spans, for which the weight estimated is 24 942 long tons (or 10 763

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* This bridge is fully described in *The Engineer,* March 18th, 1892.

† *The Engineer,* April 14th and May 19th, 1893.

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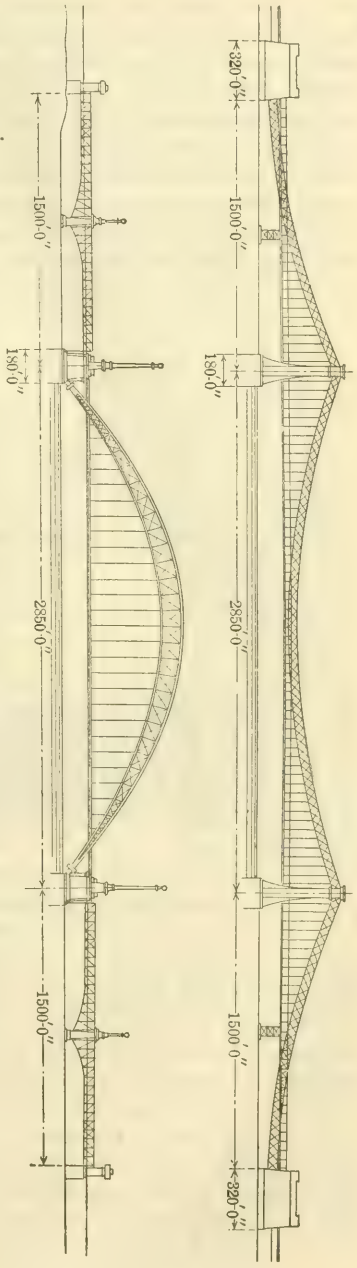
long tons in one arch span), as compared with the total of 51 000 long tons for the structure actually built. The weight of this arch design can only be approximate, but the formulas for the weights of the various portions of such spans are Mr. am Ende's Equations Nos. 10, 12, 13, 14, 23, 26, 34, and 35,* and would form a valuable basis for investigating this type. The other bridges proposed were for Quebec, of 1 600-ft. span, with a weight of 11 714 long tons (or 9 264 long tons for one arch span); for Sydney, Australia, of a 1 600-ft. span, with a weight of 11 786 long tons; and for the Bosphorus, in Turkey, a double-track bridge with a 1 240-ft. main span weighing 5 172 long tons, having a total estimated weight of only 6 072 long tons, as compared with 9 952 tons for a cantilever design, the live load being 5 600 lb. per lin. ft. of bridge. The speaker considers any type of structure which can make such a supposedly favorable showing to be worthy of investigation; and this type, moreover, is much more graceful and pleasing than many other arch-rib types.

The same engineer proposed an arch span (No. 1) of 2 850 ft. for the Hudson River at New York, Figs. 26 and 27.† This, however,



Proposed Modification

Fig. 26.

PROPOSED DESIGNS FOR A BRIDGE OVER THE NORTH RIVER, NEW YORK.

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* *The Engineer*, April 14th, 1893.

† Fully described in *The Engineer*, May 17th, 1889.

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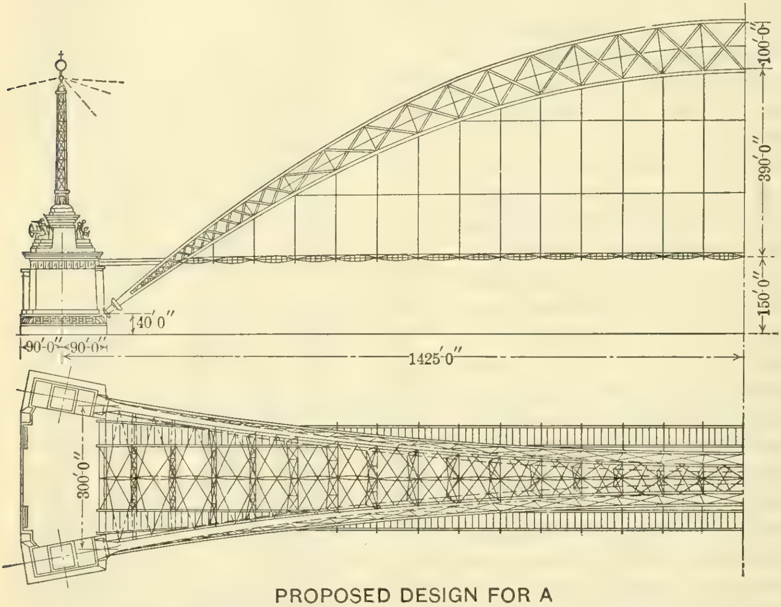
was a two-hinged sickle-shaped lattice rib of 440 ft. rise, which is only 15.5% of the span length, and indicates how top-heavy a through-arch of greater rise might become. The center depth of the rib, though only 3.5% of the span length, is 100 ft., and calls attention to the impossibility of using the 7.5% proposed by the author, especially for the longer spans. The statement of the author that 3 540 ft. is the maximum limit for an arch span, with present materials, would seem to be open to question, in view of such an unprecedented arch span having been quite carefully worked out by Mr. am Ende in 1889. The fact that proper foundations could not be secured, and that the comparisons with a suspension span are erroneous, does not detract from the value of his study and investigations.



PROPOSED DESIGN FOR A
BRIDGE OVER THE NORTH RIVER, NEW YORK.
FIG. 27.

The arch with five hinges, referred to in the classification, has not been included in Table 8, Plate III, as it is a special type which, however, is deserving of mention. The design by Charles Bender for two 1 670-ft. five-hinged arches for the Forth Bridge has been described at length by him.* He states that the weight was calculated twice independently with only 1% difference in the two estimates, so that the weight of 24 260 tons for the 5 320 ft. of bridge may be considered reasonably exact, to be compared with the 42 000 tons for the same

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* "Principles of Economy in the Design of Metallic Bridges", New York, 1885.

Mr. Fowler.

length of that bridge, as actually built, and with the weight of 24 942 tons of the more logical three-hinged parabolic arch design (No. 3) of Mr. am Ende. The five-hinged design has two cantilever arms, each of 349 ft., with the arch chord pin-bearing at the springing or abutment, and supporting a three-hinged, spandrel-braced closing or suspended span 1 002-ft. span. This is similar to the arrangement of the three-hinged fixed-end arches, Nos. 16 and 44, and is evidently worth investigating for long spans. The rise of the whole arch is 272.0 ft., or 16.3%, and 6.1 ratio of $L \div R$; the end depth is 278.0 ft., and the center depth 35.0 ft. or 2.1% of the span length. These figures denote a very well proportioned structure. Table 10 shows the proportions of all the designs for the Forth Bridge.

TABLE 10.—FORTH BRIDGE DESIGNS.

Span, in feet.	Design.	Type.	Rise, percentage.	Ratio.	Rib, percentage.
1 710	As built	Cantilever,* two-hinged	7.8	12.2	3.5
1 670	Charles Bender	Spandrel-braced, five-hinged	16.3	6.1	2.1
1 650	Max am Ende	Lattice-ribbed, three-hinged	20.0	5.0	4.3
1 640	Max am Ende	Lattice-ribbed, no-hinged	24.0	4.2	1.2

* Simply included as a comparison of arched chord.

The arches, Nos. 81, 82, 83, and 88 in Table 8, Plate III, are selected from those designed or built by the speaker, and are included in the list because all are quite striking, although they are not extremely long spans. The 255-ft. double-track railway arch at Spokane (No. 81, Fig. 28), as far as the speaker knows, is the longest spandrel-braced arch ever built with timber compression members. The design was made when C. T. Morris, M. Am. Soc. C. E., now of the Ohio State University, was Assistant Chief Engineer for the speaker, and it was planned to substitute steel compression members later for the two 10 by 24-in. arch timbers, and the other posts and struts in the structure, as the floor-beams, stringers, and bars were of steel. The erection of the arch presented no unusual difficulties, except that the erection superintendent failed to discover that the pin castings were not planed to the proper distance from the pin center, and the arch chord was consequently too long. This made the rise greater than intended (and the arch stronger), so permission was obtained to make all the diagonals turnbuckle members, and the extra camber was framed out in the ties.

The Knoxville arched cantilever, built by the speaker in 1896 (No. 68, Fig. 29), has been included as belonging to the cantilever arch type, and though possessing the desired artistic features, is possibly not as stiff under loads as even an ordinary cantilever. The spans

Mr. Fowler.

were not made true arches after erection, on account of the great height of the piers.

The first design for the Youngstown Arch (No. 88, Fig. 30) was of the type of arch with cantilever end spans (No. 89) and as shown by the author in Fig. 14, but it was not found to be as economical as the two-hinged plate-girder arch as built. The stress sheets were made under the speaker's direction by E. M. Scofield, M. Am. Soc. C. E., then Principal Assistant Engineer of the Youngstown Bridge Company, and the calculations were made by Cain's graphic method. When checking up the stress sheets before construction, the late Professor A. H. Heller, then Assistant Chief Engineer, used Howe's analytical method, and found a practical agreement. The dead-load moment was 972 000 ft-lb., the live-load moment was 2 054 000 ft-lb., and the temperature moment 368 000 ft-lb. The structure had a paved deck, 60 ft. wide, the dead load being 6 200 and the live load 4 720 lb. per lin. ft. The load was carried to the arch ribs, 8 ft. deep, by posts supporting a lattice distributing truss, 10.5 ft. deep. The sub-trussing in the 165.5-ft. approach spans was made of the same depth, for harmony, and these spans were square-ended, 30 ft. deep, to give a proper backing to the arch, for appearance. This investigation indicates that all proportions of this structure were correctly determined. The speaker has found no other two-hinged plate-girder arches of more than 200 ft. span, except the Washington Bridge over the Harlem, and the Mayence design (No. 70).

The outline of the Switch-Back Arch on the White Pass and Yukon Railway, in Alaska (No. 83, Fig. 31) was made by the late H. S. Wood, M. Am. Soc. C. E., but, owing to a change in dimensions, was re-designed by the speaker before constructing it. The design is believed to be much more economical than a true or curved arch with long vertical posts, and, moreover, it was much cheaper to erect. It was designed for two 96-ton consolidation locomotives, with a train load of 2 700 lb. per lin. ft. The outline and graphics are shown on Fig. 32. The arches at Blauw-Krantz (No. 86) and at Namti Gorge, in China (No. 98), are of the same general type, the first named being what might be termed a no-hinged, rectangular arch, and the latter a three-hinged, trussed-rafter arch.

The subject is an absorbing one, and a volume could profitably be written describing the striking features of the arches on the list, but space prevents any further discussion, except to call attention to the two three-hinged, fixed-end arches: the 626.9-ft. span at Vilaine, France (No. 16), and the 460-ft. span of the Austerlitz Bridge, in Paris (No. 44). They are the two most striking designs listed, and the latter proves how easily such a flat arch as the Alexander III Bridge could have been avoided.

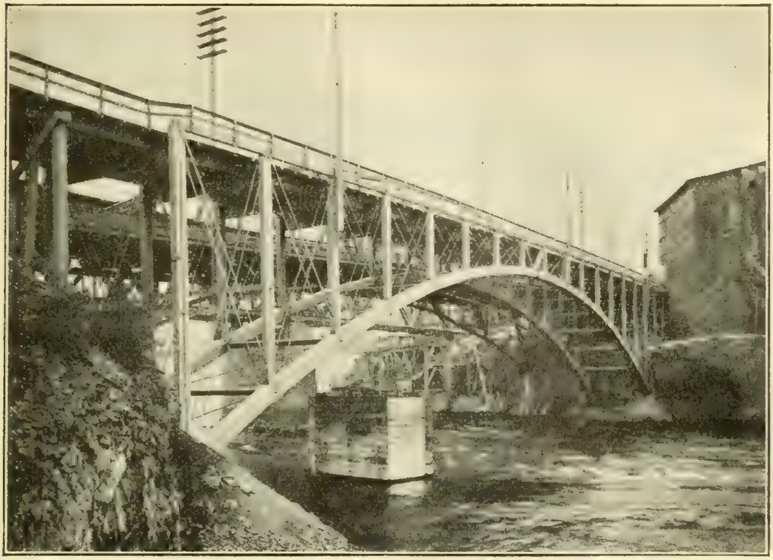


FIG. 28.—SPOKANE RAILWAY ARCH.

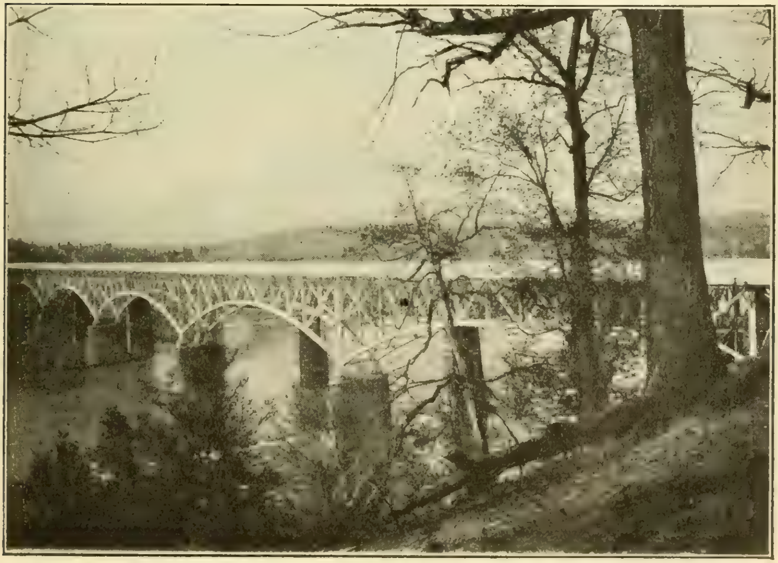


FIG. 29.—KNOXVILLE CANTILEVER.

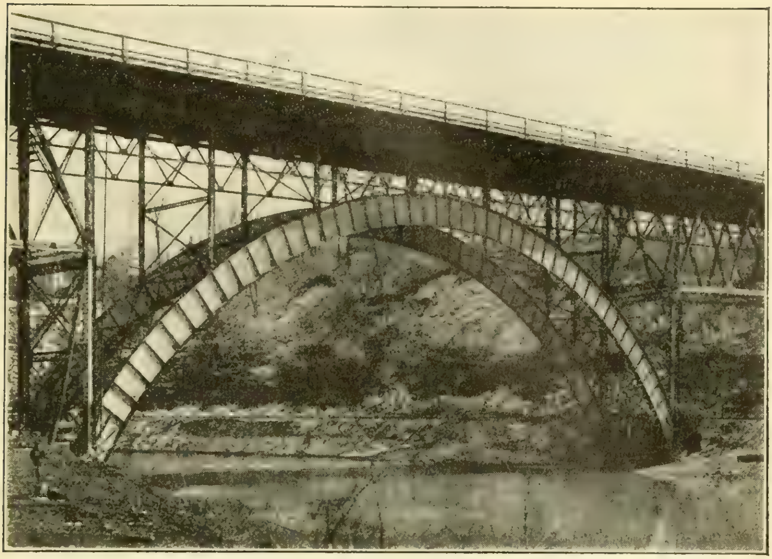


FIG. 30.—MAHONING RIVER ARCH.

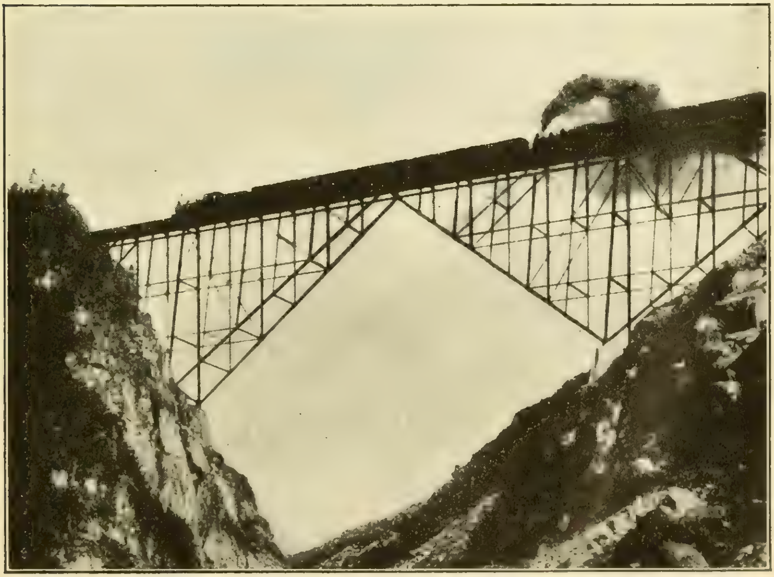
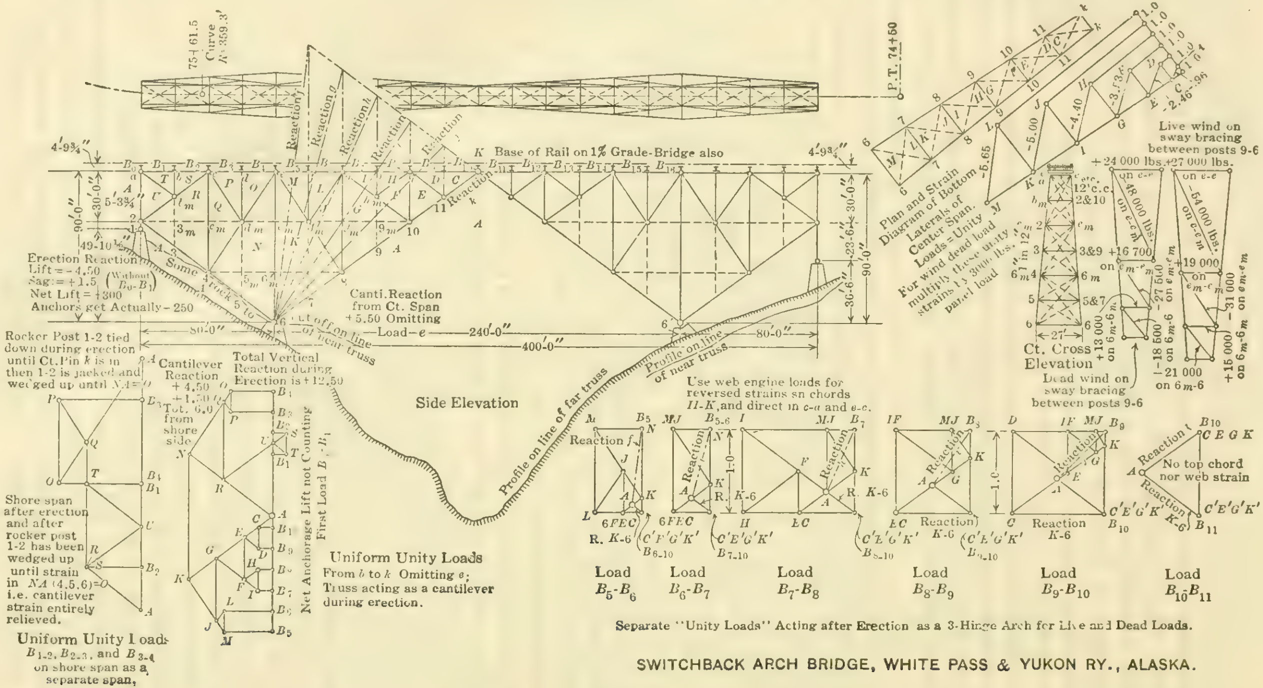


FIG. 31.—WHITE PASS AND YUKON RAILWAY ARCH.

Mr. Fowler.



Separate "Unity Loads" Acting after Erection as a 3-Hinge Arch for Live and Dead Loads.

SWITCHBACK ARCH BRIDGE, WHITE PASS & YUKON RY., ALASKA.

FIG. 32.

Mr. Fowler. The speaker's final words must call attention to the fact that the proportions fixed by him are average values for both short and long spans, and, though only small loss would result from their blind application to short spans—and ribs of too great depth would not be very unsightly for short spans—it is perceived, from a study of the longer arches, that it is often desirable to use a comparatively small rise, both as a measure of economy and as a prevention of top heaviness, and a comparatively small depth of rib, as one which is too deep would be uneconomical, unwieldy, and unsightly.

The conditions under which the load is applied to the arch rib may be a factor of economy, especially when a distributing truss is used and a considerable portion of the load is carried directly to the abutments. Then, too, the character of the steel will be a factor in fixing the economic proportions; and the entire problem of the design of large arches must be approached with an open mind, and a mind in full working order, to solve the particular case in hand.

Mr. Farr. W. B. Farr,[*] Esq. (by letter).[†]—Due to the disadvantage of having only an abbreviated form of Dr. Waddell's paper, which abbreviation, it is stated, was necessitated by economy in publication owing to present-day conditions due to the war, and also to the fact that the sheets of graphic stress calculations, diagrams of stresses, and sections of metal, etc., and other particulars necessary for the full consideration of the paper, are not accessible, it is only possible for the writer to give the subject general consideration.

There can be no question that an arch bridge, whether the arch be of masonry or of metal, is more esthetic and pleasing to the eye than any form of girder or truss bridge with the usually straight bottom boom and rectilinear opening; though it cannot be denied that some bridges with trusses of large span by their very magnitude are impressive to the ordinary observer and quite beautiful to the trained eye of the engineer who alone can thoroughly understand and appreciate them.

A number of the large truss bridges erected in recent years in the United States are imposing and have the beauty of fitness to the eye of any one able to appreciate their design and construction. Any one who has stood on the track platform of the large bridge (the largest still of its type in existence) over the Firth of Forth, near Edinburgh, Scotland, and looked down the long vista of bracings, intersecting in every direction, will be bound to admit that the sight is very imposing and beautiful, although the side elevation of the bridge, if imposing in its magnitude, cannot be said, even by one with a trained eye, to be a beautiful structure; it is, in fact, quite unnecessarily ugly.

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[*] Chester, England.

[†] Received by the Secretary, June 10th, 1918.

Unfortunately, in this utilitarian age, the point as to whether or not a bridge will be esthetic, does not decide the matter, for the engineer is bound to consider his design from the point of view of cost, and whatever type of truss or arch, etc., is decided on, must be in most cases such that the bridge can be constructed at a minimum cost. Of course, there are exceptions, but the position stated usually decides the matter. Mr. Farr.

Dr. Waddell's paper is a most valuable contribution to the information available for the use of an engineer called on to decide not only the question of arch *versus* truss in his design for a new bridge, but also the question of the type of arch, whether the ribs should be of the two- or three-hinged type and with or without spandrel bracing or without hinges and with fixed ends. Lists of weights, etc., are given for all these types and will be found to be very useful, the information available in the literature of the Profession on the subject being very meager. The economic ratio of rise to span, economic depth of rib, and location of the crown hinge in three-hinged arches are all fully discussed, and valuable particulars are given.

The tables, diagrams, etc., even as given in the abbreviated form, are interesting as closely agreeing with the results of similar problems worked out independently, but not in such detail, by other engineers. It is not quite clear why Dr. Waddell, in Tables 4 and 6, gives the total weight of metal in pounds per linear foot "per side" for ribs and lateral system, while, in Table 5, he gives it in pounds per linear foot "of structure"—which appears to be a more desirable manner of stating it than "per side"—and perhaps he will be good enough to give some explanation of the matter.

The three-hinged arch with spandrel bracing will probably be chosen in most cases, owing to the stresses and reactions being determinate and ascertainable more readily and accurately than in the case of the two-hinged type or the type with fixed ends, because in these cases before an engineer can attempt to determine the stresses and reactions, he must make certain assumptions as to the elasticity of the superstructure and of the abutments, which may be sufficiently correct in his own estimation, but not so in the judgment of others, and which hypothesis cannot be absolutely demonstrated to be correct. In the case of the three-hinged arch, however, the locus of the curve of the center of pressure being definitely known at the three-hinged points, it is, therefore, definitely known at all other points in the rib. Stresses in the superstructure due to variations of temperature, are eliminated in the three-hinged type, and these conditions will quite overbalance the defects due to the slight want of stiffness

Mr. Farr.

and greater vibrations under a moving load. It is quite inconceivable that a railway train would be allowed to cross such a structure at a high rate of speed, while in a highway bridge the vibration would be quite negligible.

The economy in the weight of metal in the arch over the simple truss appears, from the information in the paper, to commence at spans of more than 1 000 ft., but no comparison with the continuous truss of varying depth (of which the Forth Bridge is an example) is given. In bridges of several spans of more than 700 ft., a continuous truss of this type will be found to be much lighter in weight than any other truss or arch.

As it is only in the larger spans of more than 1 000 ft. that any economy in weight is shown over even a simple truss, and as the span at which the arch will come out lighter in weight than the continuous truss will be very much more than 1 000 ft., and as opportunities to construct such bridges are, especially in the Old World, of rare occurrence and not likely to enter into the experience of any but a few engineers and those in the highest ranks of the Profession, consequently, the average engineer is not likely to have an opportunity of constructing such a structure and can only as, in the writer's case, take an academic interest in the problems so ably dealt with by Dr. Waddell, to whom the thanks of the Profession both in the United States and England are due. The labor involved in the preparation of the paper and its attendant diagrams and tables must have been enormous.

In deciding on the type of bridge, in addition to the actual weights of metal in the superstructure, there is the question of abutments, nature of foundations, transportation and erection, and cost of maintenance and painting (which are too often overlooked in making an estimate of cost, as this work of maintenance, etc., frequently falls on shoulders other than those of the man designing the structure). The weight of the bearings at the ends of the three-hinged arch will vary according to the weight on them and, also requires to be taken into account, as by reason of the difficulties of, and the care required in, fixing, they may cost a considerable amount. Arches in metal are not suitable for a series of spans in a long and lofty viaduct, as it would not be possible to construct them satisfactorily on high braced or masonry piers, on account of the unbalanced thrust due to advancing moving loads over the spans. Construction of this type in such positions would probably never be seriously considered, but such viaducts are eminently suitable for crossing river gorges of comparatively narrow widths, with rocky sides forming suitable abutments to take the horizontal thrust of the arches—such as those already

Mr. Farr.

erected at Niagara, or Victoria Falls on the Zambesi, over the River Douro, at Oporto, Spain, and the Garabit Viaduct in France—where it is easy to erect the arch ribs by tying them back to temporary abutments during erection, and where it would be difficult and expensive to erect a simple truss bridge.

Mr. Van Cleve.

HORATIO P. VAN CLEVE,* ESQ.—Some one has said, "Genius is the capacity for doing work", and the speaker has had the truth of this assertion very forcibly impressed on him in reading this paper. In his preface to "Bridge Engineering" the author says that it was due to the World War, and the consequent stagnation in bridgework, that the writing of that treatise was made possible. It is probably no less true that the work on this paper could hardly have been done during the stress of the author's usual professional activity.

Some idea of the extent of the calculations incident to the preparation of the paper may be gathered from the statement—appearing as a foot-note under Problem No. 1—that seven designs were made for each of two loadings and presumably three types of rib, forty-two in all, in order to furnish data for that problem. Some short-cuts were undoubtedly made use of, but a casual consideration of the number of cases treated leaves little to be imagined regarding the extent of the labor involved.

The author's method of attacking the problems, namely, that of calculating quantities from actual designs, although more tedious, is far more practical than any wholly theoretical treatment, owing to the large number of variables involved. The latter method of investigation might perhaps have been pursued, but it would probably be more valuable as an exercise for the mathematical gymnast than as a working basis for the practical designer.

The form of the paper, although of secondary importance, deserves perhaps some attention at the hands of the critic. The speaker wishes to suggest that the matter presented would be more easily followed, and would be more convenient for reference purposes, if each natural division were prefaced by a re-statement of the problem to be solved, and, similarly, if appropriate notations were used for marking the subdivisions of the problems.

The speaker is interested in the author's proposal, in Problem No. 6, to make the arch rib three-hinged for dead load, and two-hinged for live load. It appears that a slight saving of metal would result from this expedient. To place a field splice across the crown-hinge would undoubtedly be possible, but, in the speaker's opinion, would rarely be justifiable, owing to the quantity of splice metal required, and the expense of the field drilling.

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* Chf. Draftsman, J. Edward Ogden Co., New York City.

Mr. Van Cleve.

The chief value of the paper, as the speaker sees it, lies in the fact that it forms a basis of operations in steel arch calculations, guiding the designer's judgment, and thereby eliminating much of the cut-and-try work often resorted to, only to be discarded. In filling this much felt want, it will, no doubt, fully accomplish the author's purpose.

AMERICAN SOCIETY OF CIVIL ENGINEERS
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PAPERS AND DISCUSSIONS

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IMPROVING ARCH ACTION IN ARCH DAMS

Discussion.*

By Messrs. W. P. Creager and S. H. Woodard.

Mr. Creager.

W. P. Creager† M. Am. Soc. C. E. (by letter).‡—It is very interesting to note that, of the hundreds of arch dams which have been constructed, no record of a single failure can be found. This is particularly remarkable because of the fact that less is known regarding the distribution and intensity of stresses in arch dams than in any other type of masonry dam. Perhaps this signal success with such dams can be accounted for by the remarkably large factor of safety usually adopted in the designs.

With complete information as to the distribution of stresses, as effected by a combination of water load, base shear, and expansion and contraction, the economic value of this already useful type of dam would be augmented considerably.

Although engineers may never hope to obtain perfect knowledge of the subject, the results of deflection measurements, so well described by Mr. Jorgensen, assist to a marked degree and make for economies in future designs. It is to be hoped that more data of this kind will be forthcoming.

Mr. Jorgensen's ideas regarding the desirability of initial up-stream deflection, before filling the pond, is based on sound reasoning. The greatest uncertainty regarding the distribution of stresses in arch dams is the result of the unknown effect of the so-called "cantilevering action", or horizontal shear at the base, which is caused by a down-

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* This discussion (of the paper by L. R. Jorgensen, M. Am. Soc. C. E., published in May, 1918, *Proceedings*, and presented at the meeting of June 5th, 1918), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

† New York City.

‡ Received by the Secretary, June 21st, 1918.

Mr. Creager. stream deflection of the upper part of the dam relative to that of the lower part, held rigid by the foundation. An initial deflection in an up-stream direction causes a negative shear which is eliminated on loading the dam, resulting in a negligible or at least greatly reduced positive shear and a better distribution of arch stresses.

If, as is customary, the dam is constructed during the warm season, the deflection during the cold season, after loading, will be considerably more than that theoretically due to the water load alone, on account of the shrinkage of the concrete in setting, and that due to a reduction in atmospheric temperature. The writer has been considering for some time the advisability of providing contraction joints having clear openings of a foot or more. If, before the pond rises, these contraction joints are filled with concrete during the cold season, the deflection due to the setting of the concrete and a reduction in atmospheric temperature would be obviated with beneficial results.

The advantage of carrying this remedial precaution to the extent suggested by Mr. Jorgensen depends greatly on the cost and effectiveness of such work. It would be interesting to know the results of Mr. Jorgensen's experience with the method of grouting proposed, particularly as regards the leakage of grout from the joint. Such leakage, if excessive, would be not only costly, but would greatly disfigure the down-stream surface of the dam.

Mr. Woodard. S. H. Woodard,* M. Am. Soc. C. E. (by letter).†—The author has developed a serious question to be considered in designing and building arch dams.

The general knowledge of the fact that arch dams must shorten in length by shrinkage, both when the concrete is setting and during cold weather, and that this shortening must cause re-distribution of stresses, has been in the mind of every thoughtful designer. It has been observed that nearly all straight dams and all arch dams have developed vertical cracks in cold weather, but, so far as the writer is aware, the record of actual observed deflections of an arch dam has not been published before.

The data in the paper are very useful, and probably all will agree that some steps may well be taken to accomplish what is hoped for from the grouting scheme proposed. The writer is of the opinion that, if any perfectly reliable method of accomplishing, or nearly accomplishing, this can be devised, it may well be used in preference to the grouting scheme. It is evident that, if the construction joint is only partly filled with grout, leaving certain areas without bearings when the joint is closed under pressure, the dam will be worse off than before grouting. Unless extraordinary care is taken, it will never be known whether or not the joint has been filled uniformly with grout.

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* New York City.

† Received by the Secretary, March 11th, 1918.

Mr Woardard.

The writer believes that, in most cases, wherever feasible, it will be better practice to leave narrow gaps at, say, 50-ft. intervals, and close them with concrete placed in the early spring after the dam has stood through the winter.

This, of course, will not introduce the initial stress which is hoped for from the grouting method, but here, again, unless the initial stress is uniform, the dam is better off without than with it, and there would always be some doubt on that point.

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PAPERS AND DISCUSSIONS

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DISCUSSION ON FINAL REPORT OF THE SPECIAL COMMITTEE ON STEEL COLUMNS AND STRUTS*

By Messrs. William H. Burr and R. von Fabrice.

Mr. Burr.

William H. Burr,† M. Am. Soc. C. E. (by letter).‡—The work of the Special Committee on Steel Columns and Struts has extended over a period of 9 years, one progress report having been made about a year after the creation of the Committee. After such a long period of activity, it is only reasonable to suppose that the Committee would have covered much ground in a thorough and conclusive manner, especially in view of the fact that a great testing machine of unusual power and accuracy had been placed at its disposal. It is a little disappointing, therefore, to find that the most used type of cross-section of steel column up to the present time is not included in the scope of the Committee's consideration. These tests have not included any column section in which lattice bars or stay-plates are used for holding the component parts of the column in place so as to make an effective compression member.

It is obviously of real importance to learn by actual test the resisting capacities of columns with spacing details, and also of those which are built up or rolled so that they do not require such spacing details as lattice bars and spacing plates or battens; but, as those of the former class are far more numerous than those of the latter, up to the present time, the work of the Committee would have been much more nearly complete if the investigations had included both classes. Cer-

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* Continued from April, 1918, *Proceedings*.

† New York City.

‡ Received by the Secretary, April 9th, 1918.

Mr. Burr. tainly, the element of time was not lacking to accomplish such a result.

All the columns were tested with "flat ends", unquestionably the most uncertain end condition which could be seriously considered for such a purpose. Clearly, if the end bearings could be made mathematically exact and at right angles to the axes of the columns tested, there would be reached the condition of true fixedness, at least at the beginning of the test of each column.

That condition, however, would immediately disappear, and the column would at once become eccentrically loaded—with constantly increasing eccentricity—as the load on the column increased. It will presently be shown that an increasing eccentricity of loading took place in probably every column tested in the entire series. In other words, the series of tests is one of columns eccentrically loaded, and with an eccentricity constantly increasing, and rapidly so after passing the limit of elasticity.

It is essentially impossible to face the ends of a column so as to make a strictly accurate fit at each end. Apparently, this was the case in this investigation, as the Committee states:

> "Considerable difficulty has been found in securing bearing blocks of sufficient accuracy, and it was necessary for the Bureau to go over all the blocks and dress them to a surface with a variation of not more than plus or minus 0.001 in."

Again, in the instructions issued by the Committee for testing, there is found the statement: "The ends of the columns shall be dressed flat to reduce the amount of shimming to a minimum." It can scarcely be expected that the shimmed flat end of a column would be in condition to be uniformly compressed, however carefully the shimming might have been done. In fact, it would scarcely be too much to state that any shimming whatever would be practically certain to render centric loading of the column impossible, and the extent of the eccentricity induced would be quite impossible to determine. The report does not contain any satisfactory statement as to the reason for the choice of this uncertain flat-end condition for the investigation. It was recognized among the older investigators that the flat-end condition introduces variables of eccentric bearing at one end which differ from those at the other, with the attendant eccentricity of loading, which cannot be estimated, carrying with it a corresponding amount of extraneous and uncertain bending in the column. This variable eccentricity and bending moment reduces obviously the resisting capacity of a column by an amount quite impossible to determine.

Furthermore, the flat-end column, with a few rare exceptions, is now never used in structures in other shape than columns of cast iron, and columns of this material have nearly disappeared in first-

Mr. Burr.

class work. Even in heavy riveted structural joints, the endeavor is essentially universal to make all lines of stress intersect in a point which will insure centric loading; but, even there, the elastic motions of the intersecting members prevent the fixed-end condition. It is for this and other substantial reasons that some engineers have well contended, as the writer believes, that the pin end corresponds more nearly than any other to the general conditions under which structural columns are used; and, hence, that the results of column tests with pin ends may be used safely and properly for practically all structural columns wherever they may be found.

Fortunately, the measurements of the strains at different parts of loaded columns when under test enable the preceding observations to be rather markedly illuminated. The report states that these strains were measured to $\frac{1}{5000}$ in. As such measurements, to be of greatest value, must be as accurate as possible, it is a matter of surprise that a more accurate measuring apparatus was not used, as it is now quite possible to measure, by the aid of a perfect screw, to $\frac{1}{50000}$ in., and by close estimation to less than 0.00001 in. A geared dial is not the most accurate instrument available at the present time, but it may be accepted for the present purpose.

Prior to using the data in the tabular results of the report, it is proper to state that, with this important and rather analytic subject before a committee of engineers for the period of 9 years, it would be reasonable to expect at least the fundamentals of a thorough analytic statement of the typical or principal stresses in a centrically-loaded column, if not supplemented by at least a simple outline treatment for eccentrically-loaded columns. As a matter of fact, there is not in the entire report any matter whatever, either analytic or other, bearing on the stresses found at various points of the cross-section of a loaded column, either at the ends, or at the center, or at any other section. The only intensity of stress given anywhere is the mean or average intensity, which, of course, is the same from one end of a column to the other. All conclusions reached, so far as they depend on any intensity of stress, are expressed in terms of that mean or average. Nor has there apparently been any effort on the part of the Committee to interpret in any way the significance of the varying strains at different parts of the column, although some highly important conclusions may be based on results thus disclosed.

It is sufficient here to observe that, in general, the state of stress in any column, as has long and well been known, is a combination of a uniform stress and a stress couple, as shown in Fig. 8. In that figure, $D\ K = C\ L$ is the uniform intensity of stress on any section, $K\ L$, and is the mean or average intensity shown as "Unit Ultimate Strength", or "Average Ultimate Strength", in Tables 1, 2, etc., of the report. As a matter of fact, however, the actual intensity or

Mr. Burr. compressive stress which determines the failure of the column is the quantity, *H L,* of Fig. 8, and the comparatively small intensity or compressive stress, *F K,* is found on the opposite side of the section. It can readily be seen from Fig. 8 that, comparatively speaking, the intensity of stress, *C L,* may not be of much consequence, inasmuch as the maximum intensity, *H L,* actually exists at the same point.

Referring to Fig. 9, the full line, *A C F,* represents the center line of a column with flat ends at *A* and *F,* the deflections being much exaggerated. If the ends are accurately flat and at right angles to the axis of the column when unloaded, and if the bearing surfaces are rigidly unyielding, the imposed load, if not too great, will cause the center line of the column to take the reversed curve shown, *B L* being equal to *B K,* and similarly for the other half of the column. The deflection, *A L,* will also be equal to *K C.* Hence the center deflection, *K C,* will be equal to the eccentricity of loading, *A L.* The maximum bending moment in the column, at *C* and at *A,* will be equal to the column load multiplied by *K C,* or the eccentricity, *A L.* As a matter of fact, the unavoidable inaccuracies of flat ends and the elastic motions caused by column loading derange to some extent the conditions outlined, although the principal features are, in general, approximately maintained. Bad fitting of the ends, or other influences of a similar kind, may even bring the point of reversed curvature, *B,* up near to *L* (Fig. 9), thus approximating the condition of a round end. In the present instance, however, the end fitting was doubtless unusually accurate, producing closely the ideal conditions described. With the increasing load, however, the elastic motion at the ends of a column would cause increased eccentricity, as is actually shown by the increasing measured strains.

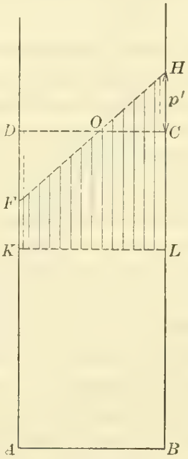

Fig. 8.

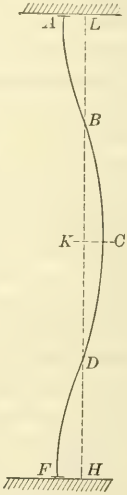

Fig. 9.

These matters may be illustrated by taking the data for Test No. 30 first with a total load of 113 600 lb. and then a total load of 284 000 lb. The compressions for the gauged length of 8 in. at the middle of the column are 0.0026 and 0.0026 in., for Points 1 and 3, and 0.0025 and 0.0028 in. for Points 5 and 7; which shows that there was irregularity of deflection, but that there was a vertical deflection. Using

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30 000 000 for the modulus of elasticity, with the preceding compressions for 8 in. in length, the intensities of stress are found to be:

For Point 1............ 9 750 lb. per sq. in.
" " 3............ 9 750 " " " "
" " 5............ 9 375 " " " "
" " 7............10 500 " " " "

These intensities show that the column deflected upward with the load of 113 600 lb., giving the following mean fiber stresses:

At Points 1 and 7..........10 125 lb. per sq. in.
" " 3 " 5.......... 9 563 " " " "

562

Hence, in Fig. 8, $p^1 = \frac{562}{2} = 281$ lb. per sq. in.

As the moment of inertia of the cross-section of this column is $I = 64.54$, and as the half depth of the column is 3 in., the moment of the stress couple, indicated in Fig. 8, is

$$M = \frac{p^1 I}{d} = \frac{281 \times 64.54}{3} = 6\,045 \text{ in-lb.}$$

Hence, the eccentricity of the load was $\frac{6\,045}{113\,600} = -\,0.053$ in.

The negative sign is used to indicate upward deflection.

When the load was increased to 284 000 lb., the strains in the gauged 8-in. length were:

At Point 1, 0.0068 in.; hence the intensity of stress = 25 500 lb. per sq. in.
At Point 3, 0.0086 in.; hence the intensity of stress = 32 250 lb. per sq. in.
At Point 5, 0.0078 in.; hence the intensity of stress = 29 250 lb. per sq. in.
At Point 7, 0.0071 in.; hence the intensity of stress = 26 625 lb. per sq. in.
Mean fiber stress at Points 1 and 7....26 063 lb. per. sq. in.
" " " " " 3 " 5....30 750 " " " "

These intensities show that the deflection was downward. Using the foregoing data, the moment of the stress couple is

$$M = \frac{2\,344 \times 64.54}{3} = 50\,419 \text{ in-lb.}$$

The eccentricity of the load was $\frac{50\,419}{284\,000} = +\,0.18$ in.

Mr. Burr. Again, the recorded results of Test No. 54, Type 2, may be used in the same way. With a load of 96 600 lb., the strains on a gauged length of 8 in. at mid-length of the column are:

At Point 1, 0.0025 in.; hence the intensity of stress = 9 375 lb. per sq. in.
At Point 3, 0.0023 in.; hence the intensity of stress = 8 625 lb. per sq. in.
At Point 5, 0.0026 in.; hence the intensity of stress = 9 750 lb. per sq. in.
At Point 7, 0.0027 in.; hence the intensity of stress = 10 125 lb. per sq. in.

These results indicate that the deflection is horizontal and to the "south". Taking half the difference of the mean intensities at Points 1 and 3, and 5 and 7:

$$p^1 = \frac{938}{2} = 469 \text{ lb. per sq. in. (Fig. 8).}$$

The moment of inertia of the cross-section is 53.84, the width of the section being 8 in. The moment of the stress couple is then

$$M = \frac{469 \times 53.84}{4} = 6\ 313 \text{ in-lb.}$$

The eccentricity of the load, therefore, was $\frac{6\ 313}{96\ 600} = +\ 0.065$ in.

Finally, with a load of 280 140 lb., the corresponding strains in the gauged length of 8 in. were:

At Point 1, 0.0068 in.; hence the intensity of stress = 25 500 lb. per sq. in.
At Point 3, 0.0060 in.; hence the intensity of stress = 22 500 lb. per sq. in.
At Point 5, 0.0105 in.; hence the intensity of stress = 39 375 lb. per sq. in.
At Point 7, 0.0116 in.; hence the intensity of stress = 43 500 lb. per sq. in.

Using half the difference of the two mean intensities at Points 1 and 3, and 5 and 7:

$$p^1 = \frac{17\ 438}{2} = 8\ 719 \text{ lb. per sq. in.}$$

Hence, the moment, M, of the stress couple is

$$M = 8\ 719\ \frac{53.84}{4} = 117\ 358 \text{ in-lb.}$$

The eccentricity, then, is $\frac{117\ 358}{280\ 140} = +\ 0.42$ in.

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These computations show that the eccentricity of loading increases with the increase of load, and that, even within the elastic limit, in Test No. 54, it was more than 5% of the width of the section. After the elastic limit is passed, the eccentricity increases rapidly, and increases the moment of the stress couple with equal rapidity. This is the explanation of the hastening failure of the column after passing the elastic limit.

The intensities of stress obtained by actual strain measurements demonstrate in a marked manner the gross error likely to be committed in basing analytic conclusions on the mean or average intensity of stress in the cross-section of a loaded column. In the case of Test No. 30, with a total load of 284 000 lb., and with a mean intensity of stress of 25 000 lb. per sq. in. at the mid-length section of the column, the strain measurements show that the mean maximum compression in the same section is 30 750 lb. per sq. in., which is 20% more than the average. The results found in connection with Test No. 54 are still more striking with a total load of 280 140 lb., giving a mean intensity of 29 000 lb. per sq. in. on the mid-length section. The strain measurements disclose a mean maximum intensity of compression of 41 400 lb. per sq. in., an increase of nearly 50% above the mean intensity. This column gave an ultimate resisting capacity of about 30 000 lb. per sq. in. as an average intensity over the entire section, but the strain measurements show that the maximum intensity of compression in the section might have been as high as from 45 000 to 50 000 lb. per sq. in., or even higher.

A large but undeterminable part of this excess of the maximum intensity of compression over the mean is directly due to the eccentricity of the column loading. Even if it is admitted that the strain measurements were not as highly accurate as could be desired—which is probably true—this analysis demonstrates conclusively that the varying and rapidly increasing eccentricity of loading in these tests is far too large an element to be ignored, and that any part of the investigation bearing on, or influenced by, the intensities of compressive stress in the cross-section of the column must take into account, at every step of the operation, the maximum intensity of stress, and not the mean.

The report contains the details of stress measurements of Tests No. 30 and 54 only. If similar details of other tests were printed, doubtless more marked cases even than No. 54 would be found.

The Committee emphasizes the fact that the programme of investigation was arranged so as to eliminate as far as practicable "all variables except that of form". The meaning of this statement is not quite clear. It certainly could not have been the intention of the Committee to eliminate the ratio, $\frac{l}{r}$, for it has been given a variation

Mr. Burr. from 50 to 120, and value would have been added to the results of the tests if other ratios than the three selected had been used. Again, it has been seen that the eccentricity of loading involved was highly variable. The carbon content was also varied. Unfortunately for the designers of structural steel columns, as has already been observed, it was decided to eliminate from the columns tested such spacing pieces as lattice bars, tie-plates, and similar details. Details of this kind have been used so widely in the past, and are still likely to be much used, that full-size tests determining their value and dimensions would be highly important in steel structural design, even at the present time.

It has been a fundamental principle in the best design of cross-section for a steel column to distribute the metal so as to make each of the different parts individually self-supporting, as far as practicable, and mutually supporting as parts of a whole, so as to maintain the full value of the radius of gyration in the direction of bending, up to the instant of actual failure. Convenience of construction, accessibility for painting, and other matters of a similar nature do not permit a perfect application of such fundamental considerations, but they do influence design strongly. The Phœnix column probably fulfilled these ideal conditions more nearly than any other section ever devised, but the inaccessibility of the interior of the column, and difficulties in detailing, would prevent any such section from coming into general structural use.

The value of this investigation would have been much enhanced if its scope had been sufficiently increased to throw the light of actual test results on the relative value of a number of forms of cross-section which, in the past, have been much used, and are still. The type of section used almost entirely by the Committee, namely, with the individual projecting flat and unsupported parts, is the least effective of all for purely column purposes, although, in one shape or another, it is widely used, and the results are correspondingly valuable.

The data obtained by the tests and shown in the tables of the report are highly interesting. The long and well-known decrease of carrying capacity due to heavy sections—that is, those of thick metal—stands out prominently, although in some instances it is masked by the varying content of carbon, as the Committee allowed "the mill to change the carbon content so as to endeavor to produce the same strength for the light material as for the heavy". This attempt to cure the influence of lack of work between the rolls by chasing it with a varying carbon content proved ineffective, as was to be expected. By retaining the same carbon content, a well-determined effect of insufficient work would have been obtained.

It is greatly to be regretted that the report did not include a graphical representation of the ultimate resistances, so as to show at

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a glance the actual relation existing between them and the column ratio, $\frac{l}{r}$. It is true that a more satisfactory probable curve could be drawn with additional results for the intermediate ratios, 68 and 138, as well as for the smaller value, 35. On Fig. 10 are shown the three main groups of tests, as well as the smaller group for which $\frac{l}{r} = 155$, and the single test for which that ratio is 20. Each of these groups actually shows considerable variation, but not more than is to be expected under the condition of flat ends, with the varying eccentricity of the increasing loading, the added influence of thickness of section, and the varying content of carbon. The extra heavy section of Type 5*B* gives strikingly low ultimate resistances, lower indeed than one would expect, even with as much thickness of metal as $1\frac{1}{4}$ in. The content of carbon may have been an important element in this case, but it does not appear to be given in the report. In any event, however, no experienced engineer would permit as high working resistances in columns having excessively thick parts as in those of lighter section.

The value of this graphical representation is that it shows at a glance, among other things, that the working stresses prescribed for columns with end conditions such as those used in this investigation should vary reasonably, not only with the column ratio, but also with other elements, such as the carbon content and the thickness of metal in the different parts of the column section, although too much importance should not be attached to this latter feature unless the thickness is sufficient to decrease markedly the work done between the rolls. If the carbon content is to be varied so as to cure insufficiency of work in rolling, careful tests should be made to determine the desired content with reasonable accuracy, so as to bring the resisting capacity of the column up to the required amount. In every feasible case, however, the needed amount of work should be prescribed and secured.

In order to make a comparison with some of the best of the older tests, there are shown on Fig. 10 the results of the tests of medium-steel angles with flat ends made by the late James Christie,* M. Am. Soc. C. E. It would have added much, both to the interest and value of this report, if the older tests of wrought-iron and steel columns had been shown in comparison with those of the present steel flat-end columns, wherever they were made by reputable experimenters. It is a mistake to assume that the best of those older tests were not sufficiently accurate to be compared with these modern results. Although it is true that the older machines were not as extremely accurate in some respects as the machine used in this series of tests, in some other respects they were at no disadvantage, and the results

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* *Transactions,* Am. Soc. C. E., Vol. XIII (1884), pp. 253 and 285.

Mr. Burr. obtained may be accepted as essentially correct. Indeed, the tests of flat-end angles made by Mr. Christie, taken in connection with others made by him at the same time, probably constitute the most interesting, and in some respects the most valuable, of all structural tests that have ever been made. His papers constitute an almost unrecognized classic in the literature of testing materials. He was, in the best sense of the word, a perfect mechanic. His intuitive sense of the fitness of details and character of appliances to secure desired—and in many cases delicate—results has seldom been equalled by any experimenter in structural materials, and his interpretation of results showed him to be, not only an engineer, but an engineer physicist.

It will be noticed that Mr. Christie's unit results are materially higher than those obtained by the Committee, up to the column ratio of 120, and practically the same at the column ratio of 155. This is doubtless largely due to the fact that he experimented with single angles, and the Committee with built-up sections. With the lower values of $\frac{l}{r}$, the riveting of a built-up section is an element of weakness, as the parts are not held rigidly in position in relation to each other, and, consequently, a slight though quite imperceptible relative motion will correspondingly reduce the unit carrying capacity. It is also partly due to the fact that more accurate flat-end fitting can be made with the smaller single-member angle struts than with the full-size columns used by the Committee. The weakening effect of the increasing eccentricity with the increasing load in the latter would be relatively greater than in the case of the single angles.

The angles tested by Mr. Christie were of mild steel, with a carbon content of 0.11 to 0.15, which is distinctly less than that found in the material used by the Committee. It may be properly observed, of course, that results obtained from the small sections of single angles are scarcely comparable with those from full-size columns. Although that is true, the comparison is legitimate, however, for it is at least illuminating as to the general features of the results.

In the older wrought-iron and steel column tests such graphical representations were always accurately made and carefully studied, enhancing greatly the value of those investigations and forming the only reliable basis for the convenient determination of the empirical quantities used both in Gordon's and the straight-line formulas. In the present instance such a graphical representation of results gives a much clearer and more complete view of the different resisting capacities for light and extremely heavy sections than is possible by any tabular statement; and other features are brought out with similar definition. A mean-resistance curve may be drawn through the mean points of the stress groups to represent the straight-line formula

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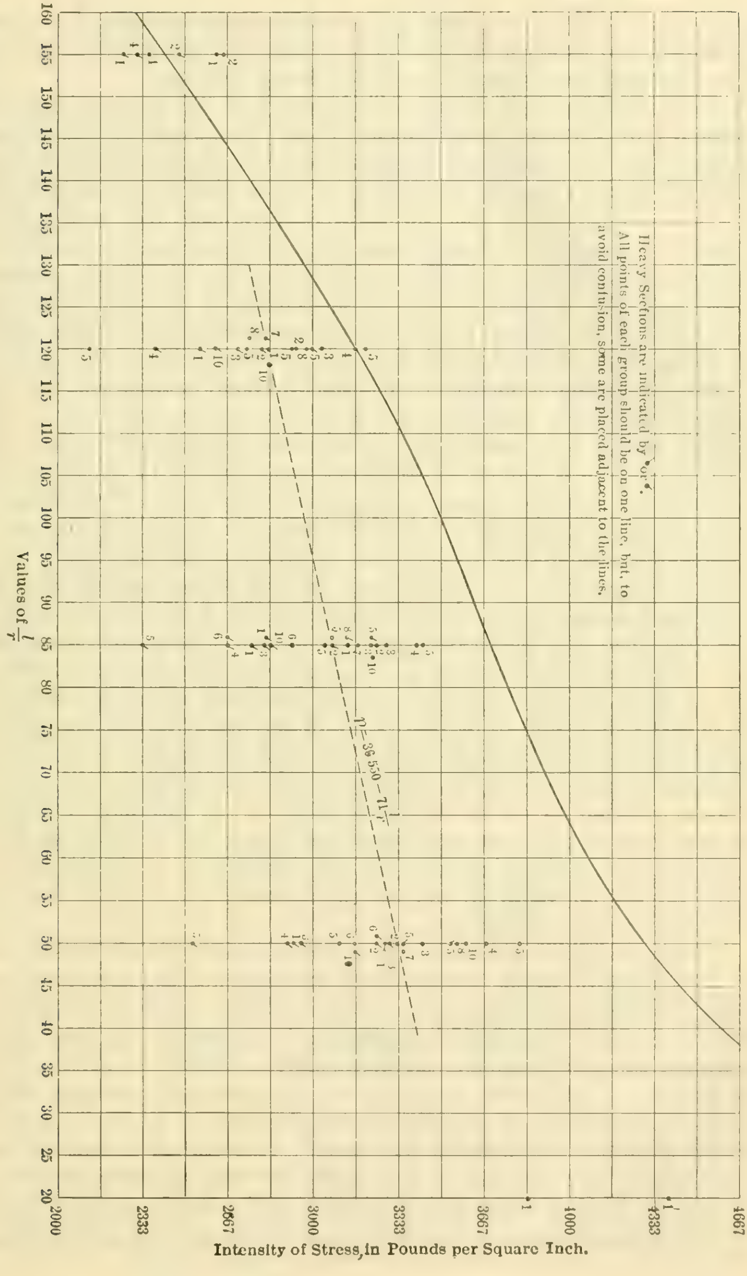

FIG. 10.

Mr. Burr. within the limits of the tests, or two such mean-resistance lines may be drawn, one through the mean points for the light sections and another through the mean points for the heavy sections.

In scrutinizing such an important report, it is natural to look for evidences of material advancement in the knowledge of the subject investigated. The principal, if not the only markedly original feature disclosed in the report is what the Committee calls the "Useful Limit Point". When a new scientific term is introduced into any field of research, it generally indicates some important physical feature or discovery corresponding to some new state or quality of the material under test, like the elastic limit or yield point in the field of testing materials. The "Useful Limit Point", however, is not a term corresponding to or signifying any new feature or quality of the material at any particular intensity of loading; in fact, it does not indicate anything whatever regarding the condition of the material in the column under test, except that it must be "somewhere" above the yield point. It is simply an arbitrary term applied to an arbitrarily chosen point on the envelope of the stress-strain curves of the column. It is a point determined by a tangent having a completely arbitrarily chosen inclination, that is, half that of "the last run-up line."*

It is unfortunate, to say the least, that the Committee should have introduced a superfluous term where simplicity is needed. It is difficult to realize why this specially arbitrary and substantially meaningless term can be supposed to acquire such value as the report accords it. It varies greatly, as does the yield point and ultimate resistance, as indeed it is bound to by the nature of the case. It has to be established by the construction of an envelope for stress-strain curves, both above the yield point and below the elastic limit. It has no definite relation to either the yield point or the ultimate resistance. In fact, it is not an exaggeration to say that it has no physical value whatever. As a matter of fact, the yield point may be located just as accurately, if not more so, and has the material advantage of meaning something in the column test.

A feature which will probably challenge some criticism is that part of the report in which is considered the safe working stress for columns "conservative enough to cover the wide range in the results shown by the Committee's programme." Inasmuch as "the usual working stress in tension is approximately one-half the elastic value of the metal", the Committee arbitrarily assumes that "columns should have a safety factor of at least two, based on the U. L. P., in order to be on a parity with tension members." It certainly is not entirely clear why a safety factor of two, based on "the elastic value of the metal" in tension, is on a parity with the safety factor of two in

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* The literary elegance of some modern scientific terms or definitions is indeed striking.

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columns based on the Useful Limit Point. Assuming that "the elastic value of the metal" means the elastic limit, there is no conclusive reason whatever for assuming that one-half the elastic limit in tension gives the same factor of safety as one-half the Useful Limit Point of a column in compression. In fact, the two things are radically different, when considered either in reference to the degree of safety in loading or as to the physical condition of the material.

The Committee then takes the average of all the Useful Limit Points of the column tests for the column ratios, 50 and 85. It then takes a mean between that average and the lowest observed value, which gives 23 450 lb. per sq. in. This value is then called 24 000 lb., and the factor of two is applied to it, giving 12 000 lb. per sq. in. for a sort of unit or base working value, which the Committee recommends, it being assumed that static loads only have been considered, "and that a percentage of the static stress will be added to cover the impact due to moving loads."

The averaging of the aggregate test results, for the column ratios of 50 and 85, without regard to the variation of that ratio, and then the averaging of that average with the lowest result obtained with excessive thickness of metal is so crude and irrational as to be entirely indefensible, irrespective of the use of the arbitrary "Useful Limit Point". Fig. 10 shows that the decrease of carrying capacity, in increasing the column ratio from 50 to 85, is too material to be neglected. Furthermore, the test results for the Type 5*B* section are seen to be phenomenally low, and should not be included in the determination of a general formula or resistance curve. Any experienced engineer would make due allowance in his working stress for such extra heavy sections.

It is greatly to be regretted that the Committee takes such a hopeless view as to the practicability of determining a reasonable column formula from the tests of full-size columns. In the paragraph at the bottom of page 2456* occurs the following statement:

> "Numerous theoretical formulas have been promulgated from time to time, all of them based on entirely elastic material of uniform grade. At the present time it seems useless to the Committee to attempt to write a rational column formula, from a theoretical standpoint, with the possibility of variations of 28% in the strength of the material."

It is true that enthusiastic analysts have proposed from time to time some rather extreme and usually extremely complicated column formulas, but probably few if any experienced engineers have regarded them seriously. The only two types of formulas which have been widely used are the so-called Gordon's and straight-line formulas.

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* *Proceedings*, Am. Soc. C. E., December, 1917.

Mr. Burr. It is certainly a fact that Gordon's formula is established from a "theoretical standpoint", but that is equally true of probably nine-tenths of all the practical formulas used by engineers. It is true of all beam formulas, which, like Gordon's, are fitted with empirical quantities or coefficients giving them sufficient accuracy for the most important practical purposes. It is not necessary, in this case, to write a column formula from a theoretical standpoint, but from the standpoint of these tests; otherwise, what value have they?

The straight-line formula was not established from a theoretical standpoint. It was first obtained by plotting the results of tests of full-size columns within the limits of column ratios of about 40 and 120, then drawing a straight line which would best represent those results, in the process of determining the corresponding numerical quantities required. It is true that some attempts have been made to establish the straight-line formula analytically, but it is an empirical formula, pure and simple; and all such attempts are defective and without analytic merit.

If a straight line be drawn through the centers of the three groups of the results of tests shown on Fig. 10 for the column ratios of 50, 85, and 120, as shown by the broken line, ignoring for the moment the three results belonging to the Type *B* cross-section, that line may be represented by the following equation, p representing the average ultimate resistance, in pounds per square inch:

$$p = 36\,550 - 71 \frac{l}{r} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

This equation holds true for all values of the column ratio between 50 and 120; indeed, it may be taken as essentially correct between 40 and 130.

This formula represents fairly the mean ultimate resistances for the different columns tested. There is a not-well-defined zone of rapid distortion of each column immediately below the ultimate resistance, which cannot be considered as of much resisting value, although the load is constantly increasing, up to the point of failure. By examining the diagrams published in the report, this zone may be taken (for illustration) at about 15%, as an average, of the ultimate resistances. Then, if 85% of Equation (1) for p is taken, and if one-half of that value is considered a safe working stress, which is reasonable, the formula for that working stress will become

$$p = 15\,500 - 30 \frac{l}{r} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

If the column ratio is 50, the working stress becomes 14 000 lb. per sq. in.; or, if the column ratios are 85 and 120, respectively, the working stresses become 12 950 and 11 900 lb. per sq. in., respectively. These values are certainly reasonable and safe; in fact, it may be said that they are rather below than above the limit of safe values. They are not given here, however, as values that should be adopted, but as illustrating the proper method of procedure to determine safe working stresses. They show that 12 000 lb. per sq. in. is not justified by these tests; and they show, further, that it is irrational and also unjustifiable to take the same unit working resistance for column ratios of 50 and 85. Finally, they certainly show, also, that it is far from useless for the Committee to attempt to write a rational column formula, either from a theoretical, or from some other, standpoint, well adapted to the purpose. If, however, it is not thought desirable to write a rational column formula from a "theoretical standpoint", the preceding operation demonstrates conclusively the possibility of writing such a formula entirely from an empirical standpoint, by the use of these test results. Mr. Burr.

A variation of even 28% in the ultimate tensile resistance of the material has no essential bearing on this point. A proper formula will represent a general run of material, and, as has been pointed out already, it is a simple matter to adjust or modify the formula for extreme cases of any kind. Indeed, there is no better way of doing this than by the aid of a formula based on the tests of columns in which the variations are found.

Mr. von Fabrice. R. von Fabrice,* Esq. (by letter).†—The report of the Special Committee on Steel Columns and Struts‡ is based on results obtained from a series of 213 tests made by the Bureau of Standards at Washington. The tests include only columns with square ends and having sections designed to avoid the necessity of lattices or battens. From the results obtained, the Committee recommends a maximum working unit stress of 12 000 lb. per sq. in. of section on all solid columns with square ends, with $\frac{l}{r} = 80$, or less, and a reduction of the unit stress per square inch, by a straight-line law, from 12 000 lb. per sq. in. for $\frac{l}{r} = 80$, to 8 000 lb. per sq. in. for $\frac{l}{r} = 120$. It must be remembered that this recommendation is only for static loads; special percentage and other allowances in loading must be made for impact and rolling loads.

No account is taken of the following unknown factors which are ever present in all kinds of structures:

Material:

(*a*)—Quality of steel.—High and low carbon.—Amount of work received.

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* Chf. Draughtsman, Public Service Elec. Co., Newark, N. J.

† Received by the Secretary, July 5th, 1918.

‡ *Proceedings*, Am. Soc. C. E., December, 1917, p. 2409.

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- (*b*)—Uniformity.—Segregations.—Hard and soft spots.
- (*c*)—Workmanship.—Initial bends.—Inadequate or poor riveting.

Condition of Loading:

- (*a*)—End bearing.—Pin or square ends.—Ends not milled perpendicular to axis.
- (*b*)—Eccentricity.—Load not applied at axis of column.
- (*c*)—Transverse loading.—Combined beam and column action.
- (*d*)—Repeated stresses.—Loads repeated and perhaps alternated many times.

Use:

- (*a*)—Overloading.—Impossibility of always determining exact loading.
- (*b*)—Secondary stresses.—Sometimes a considerable proportion of the primary stress.
- (*c*)—Deterioration or corrosion.—Exposure to corrosive elements.
- (*d*)—Facilities for inspection.—Forms of columns which may be frequently and easily examined.

Fig. 11 shows the relation between various column formulas and that recommended in the report. It also shows the great reduction in unit loading as recommended by the Committee for values of $\frac{l}{r} = 80$, or less, and its relation to other formulas previously used for column design.

The maximum value of 12 000 lb. per sq. in. of cross-section, based on tests made only for solid sections of perfect fabrication, workmanship, and extremely small variations in chemical and physical requirements, seems ultra-conservative, especially as practically all previously erected structures have been designed with values as high as 14 000 to 16 000 lb. per sq. in. as a maximum, as column failures are practically non-existent, and as there are no records available of failures of columns which were properly designed according to previously accepted formulas.

Practical experience on existing structures shows defective workmanship, such as defects in bearing, riveting, and alignment, and it is very doubtful whether a column has ever been put in place with every rivet tight and filling out the hole, without kinks or twists, with perfect alignment, uniform in material, and with 100% bearing contact at the splices.

The tests conducted by the Committee do not include latticed sections. Eccentric loading and transverse loading, which tend to reduce the strength of the structure, or increase its cost in proportion to the decrease in allowable stresses in the materials, have not been investigated.

Mr. von Fabrice.

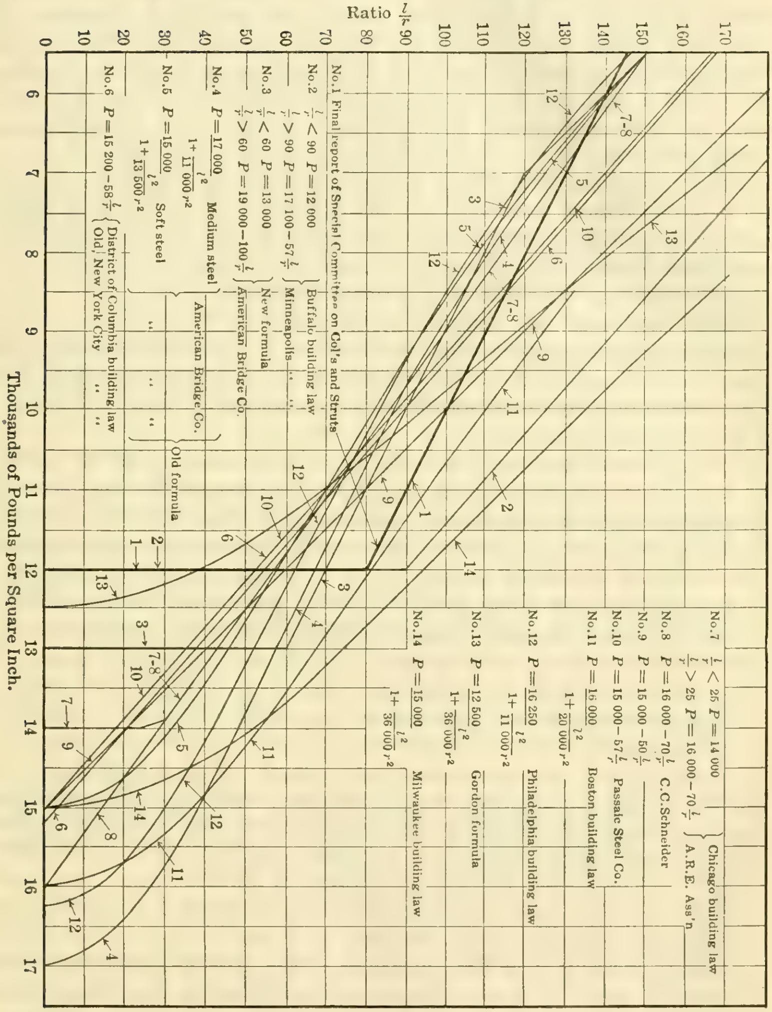

FIG. 11.

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The materials and workmanship as specified for the columns tested were far above normal. The inspection as to materials and workmanship was also more rigid, and the most careful selection of quality of specimen, that is, uniformity of metal, was obtained, which is far from practical conditions. The sections tested were over-riveted throughout, that is, a maximum riveting spacing of 4 diameters of rivet was used. The bearing surfaces were scraped so as to be as nearly perfect as possible, insuring uniform bearing throughout, a condition never obtained in practice. All computations for area of section were made by calibration, and not, as in practice, for nominal area, which amounted to as much as 4% from the nominal area.

The Committee established a working limit for the steel which it termed the Useful Limit Point. This Useful Limit Point is taken to represent the point where the metal ceases to have positive structural value and is somewhat below the ultimate unit strength of the material and slightly above the region of perfect elasticity.

The results of the tests made for Columns 5 and 5*B* are very interesting, as they show that the commonly held opinions that the failure of columns is due to the crippling of the outstanding legs, and that an angle ½ in. thick would be more than twice as strong as one ¼ in. thick, are erroneous.

The tests on Column 5 were for 8-in. **H**-columns of 32 lb. per ft., having an area of 9.17 sq. in., and that for Column 5*B* was on 8-in. **H**-columns of 91 lb. per ft., with an area of 26.64 sq. in. The average Useful Limit Point for the first three tests of Column 5, light section, was found to be 34 700 lb. per sq. in.; for the second, Column 5*B*, it was, for the first three tests, 19 700 lb. per sq. in., or a variation of 15 000 lb. per sq. in. between the light and heavy sections, or, in other words, the heavy sections were found to be only 57% as good, per unit of area, as the lighter sections.

This variation in unit strength is accounted for by the Committee as follows:

"The physical characteristics and strength of structural steel are affected by the amount of working which it receives in passing through the rolls, and, for the same size of ingot, the heavy material does not receive as much working as the light; consequently, for the same chemical composition, the heavier section is weaker."

This, however, was thought by the Committee to have been overcome by changing the carbon contents at the mill.

If this is true, then the variation of the Useful Limit Point for Columns 5 and 5*B* shows that great variations in the strength of materials are prevalent, as all the materials used were selected from supposedly the best that the mills could produce as to uniformity of product. Such being the case, it is evident that the present process of manufacture of steel is not what it should be, and that the mills

Mr. von Fabrice.

do not produce uniform metal. This would be complicated further by the fact that the present accepted commercial methods of testing do not show such variations, and, therefore, do not give correct indications as to the behavior of the steel under compressive loads. The tests at the mill indicated no such possible variation, because all the materials accepted by the Committee were practically within the limits of the specifications adopted by it, which were identical with the ordinary 60 000-lb. bridge steel, excepting that greater uniformity was required in both chemical and physical qualities.

The difference in strength of Columns 5 and 5*B* is more probably due to the fact that the distribution of the metal in the lighter **H**-section is better than in the heavy **H**-section, in relation to the neutral zones of the sections. This is contrary to the explanation given by the Committee. In built-up sections, the increase in metal is farther from the neutral zones than in **H**-sections, for the increase in weight and, consequently, the distribution of metal is in favor of the lighter column sections. If this were not the case, the box column and other sections tested should show results similar to those for Columns 5 and 5*B* for their respective light and heavy sections. Therefore, the explanation of the Committee for the behavior of Columns 5 and 5*B*, as previously mentioned, is not correct, because the strength and uniformity of the steel for the other heavy built-up sections are likewise influenced by the amount of working that the metal receives in passing through the rolls and, therefore, should show results similar to those for Columns 5 and 5*B*.

The report of the Special Committee does not recommend economy either in labor or material, nor does it suggest any means of improving the design of the columns.

The recommendations of the Committee, of using 12 000 lb. per sq. in. as a maximum, if accepted by the Profession as standard for column design, will tend to increase the costs of all construction, which does not seem to be justified, in view of the great quantity of existing work based on higher stresses and giving satisfactory results.

To use the lower stresses recommended by the Committee might be justifiable for long columns which are subjected to the full 100% of the maximum calculated column loading. This condition of column loading, however, is the exception rather than the rule, and, as it is doubtful whether a column ever will receive the maximum load from all sources at any one time, a large factor of safety (partly unknown) is introduced automatically into the design.

The Useful Limit Point for square-ended, solid-section columns was specified by the Committee at 24 000 lb. per sq. in., therefore, the use of 12 000 lb. per sq. in. as a maximum will give an actual safety factor of two.

Mr. von Fabrice.

Previous column formulas based on an ultimate compressive strength of from 60 000 to 64 000 lb. per sq. in., and allowing from 15 000 to 16 000 lb. per sq. in. as a maximum, did not permit a factor of safety of four within the "positive structural" value of the steel.

Using the value, 12 000 lb. per sq. in., as recommended by the Committee, and conceding the fact of its correctness, the former maximum stress of 16 000 lb. was really 75% of the reliable strength of the structure, allowing in reality only 8 000 lb., or 50% for safety, instead of, as formerly assumed, 300% of additional strength. Considering the actual practical variations in workmanship, bearing, riveting, etc., it is fair to assume that, for columns designed for a maximum stress of 16 000 lb. per sq. in., the remaining allowable actual 50% is easily absorbed; therefore, the former stresses used in column design do not give any theoretically available actual factor of safety, and the actual factor of safety in existing structures is obtained solely by the condition of partial loading, as mentioned previously.

The limiting value of 12 000 lb. per sq. in. for maximum stress, for columns with ratios of $\frac{l}{r} = 80$, or less, is not verified or justified by observations on existing structures which were designed for higher values; therefore, the Committee's recommendation does not confirm the experiences of actual practice.

From the report the following deductions can be made:

1. That the present commercial, physical, and chemical tests are unreliable for correct indications as to the behavior of metal under practical loading, where used as columns or struts.

2. That the present process of manufacture of steel does not produce metal which is of uniform strength, even though the present commercial tests would indicate it to be of such strength.

3. That heavy sections are weaker per unit of area than those of thinner metal.

4. That the actual excess strength in existing structures is nearer 50% than 300%, as formerly assumed, or a factor of safety of one-half instead of four.

5. That the statement: "the form of section has no material influence on the strength of the column", is disproved by tests on Column 5 and 5*B* only.

6. That bulb angles in columns are no stronger than plain angles of equal section.

7. That the unit stresses as formerly used are excessive, and in no case should a greater loading than 12 000 lb. per sq. in. be used.

8. That the statement: "Ratio of thickness to width of outstanding flanges is not the controlling feature for strength of a column", is disproved by Columns 5 and 5*B* only.

9. That the physical characteristics and strength of structural steel are uncertain quantities (if the Committee's explanation for behavior of Columns 5 and *5B* is accepted). Other tests show only slight variation. Mr. von Fabrice.

10. That the recommendations were based on the tests made under the most favorable conditions as to workmanship and material, conditions which do not obtain in practice.

11. That the former safety factor of four, as applied to the ultimate tensile strength, is equivalent to a factor of about two, based on the yield point.

12. That, if the columns are to be as strong as tension members, they must be designed with a factor of safety of two, on a basis of Useful Limit Point.

13. That some basis of specifying the amount of working that the metal should receive per unit of volume, in its transformation from ingot to finished shape, should be devised.

14. That the Useful Limit Point of steel, as established by the Committee, gives a more tangible or serviceable indication of the ultimate behavior of the metal and bears a definite and fairly constant relation between the results of the final and specimen tests.

AMERICAN SOCIETY OF CIVIL ENGINEERS
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PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications.

DISCUSSION ON FINAL REPORT OF THE SPECIAL COMMITTEE ON CONCRETE AND REINFORCED CONCRETE*

By Clinton S. Bissell, M. Am. Soc. C. E.

Mr. Bissell.

Clinton S. Bissell,† M. Am. Soc. C. E. (by letter).‡—In connection with the Final Report of the Special Committee on Concrete and Reinforced Concrete, the writer notes with interest the following statements in the discussion§ by A. H. Rhett, Assoc. M. Am. Soc. C. E.:

> "The Appendix to the report repeats the usual or standard textbook formulas for proportioning concrete beams. It has always seemed to the writer that though these formulas are normal for the analysis of a beam already built, they certainly operate in a reverse and roundabout manner for proportioning a new beam.
>
> "One must first find p, a proportion of an unknown area, then K, a proportion of an unknown depth, then j, which is a fraction of the real depth, and then d; and, from d, one then works back to the absolute value of p.
>
> "It is perfectly possible to solve a reinforced concrete beam as directly as a steel beam, and from the same basic elements, that is, the bending moment and the assumed fiber stresses and moduli of elasticity. * * *"

This criticism of the method of design is entirely justifiable, in the writer's mind. The method is one of approximation, and frequently leads to designs, the proportions of which are not in close conformity with the theory as presented.

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* Continued from February, 1918, *Proceedings*.

† Philadelphia, Pa.

‡ Received by the Secretary, July 1st, 1918.

§ *Transactions*, Am. Soc. C. E., Vol. LXXXI (1917), p. 1155.

Mr. Bissell.

The standard notation and equations given in the Appendix to the report have been adhered to in what follows, and a few new symbols invented, such as are necessary to demonstrate a direct method for the design of reinforced beams and slabs. In the ideal beam, the resisting moment of compression, commonly called M_c, must equal the resisting moment of tension, commonly called M_s. This condition is realized by the use of the "steel ratio for balanced reinforcement" (Equation (5)), and by a fact which seems to have escaped notice heretofore, within the writer's observation, namely, when the two resisting moments are equal, the neutral axis of the beam is at a distance k from the compressive face of the beam such that:

$$k = \frac{n\,f_c}{f_s + n\,f_c} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The report, (Equation (5)), gives the ideal percentage as:

$$p = \frac{1}{2} \, \frac{1}{\frac{f_s}{f_c}\left(\frac{f_s}{n\,f_c} + 1\right)}$$

Both equations apply in the case of beams reinforced for tension only, and also in the case of doubly reinforced beams.

For the moment, let the truth of these statements be assumed, and referring again to the report, (Equations (2) and (21)):

$$j = 1 - \frac{1}{3}\,k$$

$$f_s' = n\,f_c \, \frac{k - \frac{d'}{d}}{k}$$

It will be observed that, with one exception, these equations require for their solution only values for n, f_c, and f_s. The exception is the ratio $\frac{d'}{d}$ in Equation (21). This is taken at $\frac{1}{10}$, provisionally, so that the practitioner may deduce k, p, j, and f_s', for any set of unit stresses and elastic ratio, n, which may be desired.

The compressive steel in a doubly reinforced beam is usually predetermined as a proportion, r, of the steel in tension, that is, $A' = rA$; for example, if A' is to be $\frac{1}{3}$ of A, then $r = \frac{1}{3}$. A new constant, G, will be used, involving r and the width, b, of the beam, in inches:

$$G = \frac{b\,p\,f_s\,f_s'}{\frac{f_s}{r} - f_s'} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Two additional constants, K' and K, which probably are not new, will also be required:

$$K' = p\,b \qquad \text{(3)}$$

$$K = p\,b\,f_s\,j \qquad \text{(4)}$$

An elementary factor, m, of the bending moment, must also be determined. This is nothing more nor less than the bending moment of 1 in. of depth of beam; that is, if the concrete in the beam weighs 150 lb. per cu. ft., for example, and the beam is supported at each end, freely, over a span of, say, 20 ft., and is to be 10 in. wide, then the weight, W, of a 20-ft. element, 10 in. wide and 1 in. deep, will be:

$$\left(\frac{10}{12}\right) 150 \times 20 \left(\frac{1}{12}\right) = 208.33 \text{ lb.},$$

and, as the moment is $W \frac{1}{8}$, we have, for the elementary bending moment, $m = \frac{208.33 \times 20 \times 12}{8} = 6\,250$ in-lb. Had this beam been a cantilever, having a moment, $W \frac{1}{2}$, the element would have been $\frac{208.33 \times 20 \times 12}{2} = 25\,000$ in-lb. Hence, $m =$ the bending moment, in inch-pounds, of an element of a beam 1 in. deep and b in. wide.

The total bending moment, M, which a beam is required to sustain, consists of the moments of all weights and allowances due to live load, impact, road paving, tracks, etc., including that due to the weight of the beam itself. This latter moment is evidently equal to $m\,(d + d'')$, in which d'' is the distance from the center of the tensile steel to the tension face of the beam, and the remaining part of the total moment, M, may be designated as the external moment, M_E, all parts of which are specified or otherwise known. Hence,

$M_E =$ the external bending moment, in inch-pounds, which the beam must sustain in addition to the moment due to the weight of the beam itself.

The final equations for the design of beams and slabs may be readily derived; they are as follows:

For tensile reinforcement only:

$$d = \sqrt{\frac{M_E + m\,d''}{K} + \left(\frac{m}{2\,K}\right)^2} + \frac{m}{2\,K} \qquad \text{(5)}$$

$$\left.\begin{array}{l} A = K'\,d\text{; and } M = M_E + m\,(d + d'') \\ \text{For check: } \quad d = \sqrt{\dfrac{M}{K}} \end{array}\right\} \qquad \text{(6)}$$

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For doubly reinforced beams:

Case I.—When the depth of the beam is unlimited:

$$d = \sqrt{\frac{M_E + m\, d''}{K + 0.9\, G} + \left(\frac{m}{2\,(K + 0.9\, G)}\right)^2} + \frac{m}{2\,(K + 0.9\, G)} \ldots (7)$$

which gives d when the ratio, $\frac{d'}{d} = \frac{1}{10}$.

$$d = \sqrt{\frac{M_E + m\, d''}{K + G} + \left(\frac{m + G\, d'}{2\,(K + G)}\right)^2} + \frac{m + G\, d'}{2\,(K + G)} \ldots\ldots (8)$$

$$A' = \frac{G\, d}{f_s'};\ A = \frac{A'}{R};\ \text{and } M = M_E + m\,(d + d'') \ldots\ldots (9)$$

Case II.—When the depth of the beam is limited:

$$X = \frac{M - K\, d^2}{f_s\,(d - d')} \ldots\ldots\ldots\ldots (10)$$

$$A = X + K'\, d;\ A' = \frac{X\, f_s}{f_s'\,(d - d')};\ \text{and } r = \frac{A'}{A} \ldots\ldots (11)$$

All the constants in these equations may be deduced by Equations (1) to (4), inclusive.

The working equations resulting from the introduction of the known values used for any given case are simple, and easy of application. It is found convenient to assume a width, b, of 12 in. in forming the equations, as it is the usual width of an element for slabs. Furthermore, the external bending moment, M_E, can always be reduced to an equivalent for 12 in. of width, as it is directly proportional, that is, a moment of 800 000 in-lb., for a beam 8 in. wide, would be 100 000 in-lb. per inch of width, or, 1 200 000 in-lb., for a beam 12 in. wide. The areas of steel reinforcement determined for the 12-in. beam must be multiplied by $\frac{8}{12}$, in order to give the proper value for the 8-in. beam. The same reduction must be made for the total moment, M.

Assuming that the working values are to be $b = 12$, $n = 15$, $f_s = 16\,000$, and $f_c = 650$, we have from the foregoing equations:

For tensile reinforcement only (Equations (5) and (6)):

$$d = \sqrt{\frac{M_E + m\, d''}{1\,290} + \left(\frac{m}{2\,580}\right)^2} + \frac{m}{2\,580} \ldots\ldots\ldots (a)$$

$$A = 0.0923 \times d \ldots\ldots\ldots\ldots (b)$$

$$M = M_E + m\,(d + d'');\ \text{for check, } d = \sqrt{\frac{M}{1\,290}} \ldots\ldots (c)$$

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For double reinforcement (Equations (2), (7), (8), and (9)):

Case I.—When d is unlimited:

$$G = \frac{10\ 595\ 400}{\frac{16\ 000}{r} - 7\ 175} \ldots\ldots (d)$$

$$d = \sqrt{\frac{M_E + m\,d''}{1\ 290 + 0.9\ G} + \left(\frac{m}{2\,(1\ 290 + 0.9\ G)}\right)^2} + \frac{m}{2\,(1\ 290 + 0.9\ G)} . (e)$$

$$A' = \frac{d\ G}{7\ 175};\ A = \frac{A'}{r};\ \text{and } M = M_E + m\,(d + d'') \ldots\ldots (f)$$

These five equations determine the beam when the ratio of $\frac{d'}{d} = \frac{1}{10}$; as d is now known, the ratio, $\frac{d'}{d}$, may be found for any desired value of d', and the following equations apply:

$$f_s' = 9\ 750\ \frac{0.3786 - \frac{d'}{d}}{0.3786} \ldots\ldots (g)$$

$$G = \frac{1\ 477 \times f_s'}{\frac{16\ 000}{r} - f_s'} \ldots\ldots (h)$$

$$d = \sqrt{\frac{M_E + m\,d''}{1\ 290 + G} + \left(\frac{m + G\,d'}{2\,(1\ 290 + G)}\right)^2} + \frac{m + G\,d'}{2\,(1\ 290 + G)} \ldots (i)$$

$$A' = \frac{d\ G}{f_s'};\ A = \frac{A'}{r};\ \text{and } M = M_E + m\,(d + d'') \ldots\ldots (j)$$

Case II.—When d is limited (Equations (10) and (11)):

The total bending moment, M, in this case is known:

$$X = \frac{M - 1\ 290\ d^2}{16\ 000\,(d - d')} \ldots\ldots (k)$$

$$\left.\begin{aligned} & A = X + 0.0932 \times d;\ A' = \frac{X \times 16\ 000}{f_s'}; \\ \text{or,}\quad & A' = \frac{X}{1.61\left(0.3786 - \frac{d'}{d}\right)} \end{aligned}\right\} \ldots\ldots (l)$$

To illustrate the use of these equations by working the same example under all three cases, let it be assumed that a beam is to be designed, having a span of 24 ft.; that the beam is freely supported at each end $\left(\text{that is, the moment of its weight will be } W \frac{1}{8}\right)$; and

Mr. Bissell. that the material in the beam weighs 150 lb. per cu. ft., the remaining data being as follows: $f_s = 16\,000$; $f_c = 650$; $n = 15$; $b = 12$ in., as above; $d'' = 3$ in.; and $M_E = 900\,000$ in-lb. For this beam,

$$m = \frac{1 \times 24 \times 150 \times 24 \times 12}{12 \times 8} = 10\,800 \text{ in-lb.}$$

Example 1.—For tensile reinforcement only, applying Equations (a), (b), and (c):

$$d = \sqrt{\frac{900\,000 + (10\,800 \times 3)}{1\,290} + \left(\frac{10\,800}{2\,580}\right)^2} + \frac{10\,800}{2\,580} = 31.4 \text{ in.}$$

$A = 0.0923 \times 31.4 = 2.90$ sq. in.

$M = 900\,000 + 10\,800\,(31.4 + 3) = 1\,271\,520$ in-lb.

Check: $$d = \sqrt{\frac{1\,271\,520}{1\,290}} = 31.4 \text{ in.}$$

Example 2.—For double reinforcement in which $d' = 2.5$ in., and $A' = \frac{1}{3}A$, or $r = \frac{1}{3}$, the other known values being the same as in Example 1.

Applying Equations (d) and (c):

$$G = \frac{10\,595\,400}{\dfrac{16\,000}{\dfrac{1}{3}} - 7\,175} = 259.53$$

$$d = \sqrt{\frac{932\,400}{1\,524} + \left(\frac{10\,800}{3\,047}\right)^2} + \frac{10\,800}{3\,047} = 28.42 \text{ in.}$$

This, however, is for a beam in which $\frac{d'}{d} = \frac{1}{10}$, or $d' = 2.84$ in. Ordinarily, this determination will be sufficient, and Equation (f) may be used:

$$A' = \frac{28.42 \times 259.53}{7\,175} = 1.028 \text{ sq. in.}; \quad A = \frac{A'}{\dfrac{1}{3}} = 3.084 \text{ sq. in.};$$

$$M = 900\,000 + 10\,800\,(28.42 + 3) = 1\,239\,340 \text{ in-lb.}$$

To be more exact, however: the ratio, $\frac{d'}{d} = \frac{2.5}{28.42} = 0.0880$. and, applying Equations (g), (h), (i), and (j):

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$$f_s' = 9\,750 \frac{0.2906}{0.3786} = 7\,483.7 \text{ lb. per sq. in.}; \; G = \frac{1\,477 \times 7\,483.7}{40\,516.3} = 272.82$$

$$d = \sqrt{\frac{932\,400}{1\,563} + \left(\frac{11\,482}{3\,126}\right)^2} + \frac{11\,482}{3\,126} = 28.37 \text{ in.}$$

$$A' = \frac{28.37 \times 272.82}{7\,483.7} = 1.034 \text{ sq. in.}; \; A = \frac{A'}{\frac{1}{3}} = 3.103 \text{ sq. in.}$$

$$M = 900\,000 + 10\,800\,(28.37 + 3) = 1\,238\,800 \text{ in-lb.}$$

A second exact method is to use the value, $d = 28.42$, and the moment, 1 239 340, in Case II, where d is limited. In this case, the ratio, r, will be slightly affected:

Example 3.—Case II, in which d is to be 28.37 in., the other known values to be the same as in Example 2; here, the total moment, M, is 1 238 800 in-lb.; applying Equations (k) and (l):

$$X = \frac{1\,238\,800 - 1\,290\,(28.37)^2}{16\,000\,(28.37 - 2.5)} = 0.4845$$

$$A = 0.4845 + 0.0932 \times 28.37 = 3.103 \text{ sq. in.}$$

$$A' = \frac{0.4845}{1.61\,(0.3786 - 0.0880)} = 1.034 \text{ sq. in.}$$

which agree with the values in Example 2.

It will be noted that the proportions derived by these equations are adequate to sustain both the external moment and the moment due to the weight of the beam itself.

It will also be found on trial that the resulting proportions agree with the equations given in the report, which goes far to prove the truth of the statements made by the writer in introducing the subject.

The mathematical proof is to be found by equating the moments about the neutral axis, and combining these results with the linear proportions of the deformation diagram, which involve the moduli of elasticity.

It will also be observed that the writer's Equation (1):

$$k = \frac{n\,f_c}{f_s + n\,f_c},$$

which expresses this relation, is the same as Equation (20) in the report.

The use of these equations affords a direct solution in each of the cases mentioned, and the results obtained will be found to be in exact conformity with the equations cited in the report.

MEMOIRS OF DECEASED MEMBERS

NOTE.—Memoirs will be reproduced in the volumes of *Transactions*. Any information which will amplify the records as here printed, or correct any errors, should be forwarded to the Secretary prior to the final publication.

VAN BRUNT BERGEN, M. Am. Soc. C. E.*

Died April 27th, 1917.

Van Brunt Bergen was born at Bay Ridge, N. Y., on April 29th, 1841. He was a son of the Hon. Teunis G. Bergen and Elizabeth Van Brunt Bergen. He was graduated from the Brooklyn Collegiate and Polytechnic Institute in 1859, and in 1860 entered Rensselaer Polytechnic Institute, at Troy, N. Y., from which he was graduated in 1863, with the degree of Civil Engineer.

In 1864, Mr. Bergen was appointed Rodman on the Brooklyn Water Works, and thereafter served in various capacities in the Department of City Works under Chief Engineers Kirkwood, Lane, and Adams. On the resignation of the latter, in the early Seventies, he became First Assistant to Chief Engineer Robert Van Buren, M. Am. Soc. C. E., and continued in that capacity until the resignation of Mr. Van Buren in 1893. Mr. Bergen was then appointed Chief Engineer, and as such served under the administration of Mayor Schieren, with Mr. Alfred T. White as Commissioner of City Works, for a period of about two years. Mr. Bergen then retired from public service and devoted most of his time to the management of his large real estate holdings in Brooklyn.

Mr. Bergen's principal engineering work, while in the service of the City of Brooklyn, was the laying of the 48-in. water main from the Ridgewood Reservoir to the corner of Clinton and Atlantic Avenues; the construction of quite a number of the city's sewers; the development of the city's water supply in the valley of the Hempstead stream; and much other work connected with the water supply of the city.

In 1884, he compiled a short account of "The Department of City Works, Water and Sewerage," which was printed in "Stiles' History of the County of Kings and the City of Brooklyn, New York."

Mr. Bergen was a member of the following clubs and societies: The Engineers Club of New York, the Hamilton and Crescent Athletic Clubs of Brooklyn, the Holland, St. Nicholas, and the Long Island Historical Societies, and also of many scientific associations.

On August 3d, 1871, he was married to Elizabeth Emma van der Veer, daughter of Cornelius van der Veer, of Somerville, N. J. One child, a son, Henry van der Veer Bergen, was born on August 8th, 1873.

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* Memoir prepared by Gustave Kaufman, M. Am. Soc. C. E.

After his retirement from active engineering work, Mr. Bergen traveled extensively in the United States, Canada, Mexico, the Levant, and Egypt.

He was a quiet and modest man, of very high attainments. He had a very kind disposition, and was held in high esteem by all who knew him.

Mr. Bergen was elected a Member of the American Society of Civil Engineers on June 17th, 1868.

HERBERT JAMES CHAMBERS, M. Am. Soc. C. E.*

DIED MAY 20TH, 1918.

Herbert James Chambers, the only son of James and Fanny (Flood) Chambers, was born in Brookfield, Mass., on November 7th, 1872. His education was received at the Brookfield Public Schools, including the High School, and at the Worcester Polytechnic Institute, from which he was graduated in 1895.

From July, 1895, to August, 1900, Mr. Chambers was employed as Draftsman and Engineer by several New England companies, among which were the Springfield Construction Company and the Berlin Iron Bridge Company.

In 1900, he came to New York City, and, in August of that year, entered the employ of Milliken Brothers, which firm was engaged in engineering and construction work in foreign countries. In 1902, he was promoted to the position of Contracting Engineer, which place he retained until July, 1907, when he resigned to enter into partnership with John W. Hamilton, M. Am. Soc. C. E., as a member of the firm of Hamilton and Chambers. This partnership which was organized for the purpose of conducting an engineering and contracting business, was eminently successful, and, in 1916, was incorporated as the Hamilton and Chambers Company, Incorporated. At the time of its re-organization, Mr. Chambers became the Treasurer of the Company, which office he held until his death, at his home in Mount Vernon, N. Y., on May 20th, 1918.

He was a man of strong character and had a high standard of conduct which impressed all who came in contact with him both in business and social relations. He was an intelligent, energetic and capable engineer, with a strong grasp of detail, which enabled him to prosecute his work most successfully, and he has left a record of probity with the men with whom he was associated, which, without question, will influence their conduct of life.

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* Memoir prepared by J. W. Hamilton, M. Am. Soc. C. E.

In 1900, Mr. Chambers was married to Miss Marion French, of Attleboro, Mass., who, with a daughter, Adelaide French Chambers, survives him.

He was a member of the National Geographic Society, the Sewanoy Country Club, the Whitehall Club, and the Engineers Club of New York City.

Mr. Chambers was elected an Associate Member of the American Society of Civil Engineers on November 5th, 1902, and a Member on January 3d, 1911.

JAMES AUBREY DAVENPORT, M. Am. Soc. C. E.*

Died March 15th, 1918.

James Aubrey Davenport was born at Athens, N. Y., on February 27th, 1858. He received his early education from a private tutor. After some engineering training, he entered the employ of the Shenandoah Valley Railroad Company, with headquarters at Charlestown, W. Va., serving as Chainman, Rodman, and Instrumentman, in 1878, 1879, and 1880, when he was made Assistant Engineer. He remained with the Company in that capacity until the completion of the line to Roanoke, Va., in 1881.

He was then appointed Assistant Engineer on the Norfolk and Western Railroad and, as Resident Engineer, had charge of important work in connection with the grading of grounds and construction of buildings for the Roanoke Machine Works, a subsidiary of the Norfolk and Western Railroad Company, now known as the Roanoke Shops of that Company. From 1885 to 1887, he was employed as Assistant Engineer on surveys for the Railway Company.

From 1887 to 1890, Mr. Davenport served as Roadmaster and Division Engineer, on maintenance of way, on the Richmond and Danville Railroad (now the Southern Railway). In 1890, he was transferred from the Western North Carolina Division to the Georgia Pacific Division, of the same road, where he remained as Division Engineer on maintenance of way until 1895, when he was appointed Assistant Engineer on the construction of the Central of Georgia Railway.

In 1900, Mr. Davenport returned to the Norfolk and Western Railroad as Assistant Engineer, and was put in charge of work, under W. W. Coe, M. Am. Soc. C. E., then Chief Engineer, incident to railway surveys and double-tracking. On January 1st, 1903, Charles S. Churchill, M. Am. Soc. C. E., succeeded Mr. Coe as Chief Engineer, and Mr. Davenport was continuously employed, under the Chief Engineer of the Norfolk and Western Railway, in charge of heavy tunnel work and double-track and branch line construction of importance, until September, 1916, when he was granted an indefinite leave of absence on account of ill health. He died at his home in Roanoke, Va., on March 15th, 1918, and was buried at Charlestown, W. Va. He is survived by his wife and four sons.

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* Memoir prepared by the Secretary from information on file at the Headquarters of the Society.

In the record of his services to the Norfolk and Western Railroad, it is stated that Mr. Davenport was "a most faithful and competent employee", and that he performed his duties as Assistant Engineer with ability and fidelity to his employers.

Mr. Davenport was elected a Member of the American Society of Civil Engineers on April 5th, 1905.

CLARENCE BOOTH LAMONT, M. Am. Soc. C. E.*

Died March 21st, 1918.

Clarence Booth Lamont was born in Van Etten, N. Y., on February 23d, 1877, his parents having been Clarence Lamont and Iva A. Booth Lamont. After receiving a common school education, he entered Cornell University, from which he was graduated in 1900, with the degree of Mechanical Engineer.

Before going to college Mr. Lamont had evinced a strong interest in machinery and mechanical work. From June, 1894, to September, 1896, he had been engaged with the Singer Manufacturing Company on general office work and as Assistant on construction, and, during his college vacations, he found employment at Cramp's Shipyards, at Philadelphia, Pa., and in other shops. All this practical training was of great benefit to him in his theoretical work in college, and provided him with splendid equipment for his future career.

After his graduation Mr. Lamont began work at the great shipbuilding and engineering plant of the Union Iron Works, at San Francisco, Cal., which, even at that time (1900), was the best organized and equipped plant of the kind on the Pacific Coast. His work in designing for this Company continued from July, 1900, to February, 1901, and the experience gained in this capacity enabled him to make rapid progress in subsequent work. He then entered the service of the Government as Hull Draftsman for the United States Navy Department, where he was employed until May, 1901.

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* Memoir prepared by Charles Evan Fowler, M. Am. Soc. C. E.

The expansion of the plant of the Moran Brothers Company, at Seattle, Wash., where the battleship *Nebraska* was built, gave Mr. Lamont a great opportunity. He entered the employ of that Company in June, 1901, as Assistant Engineer and Designer in charge of several other designers, and his intelligent work was no small factor in the development of the present great works.

The Company operating the White Pass and Yukon Railway, running from Skagway, Alaska, to White Horse, on the Yukon River, owned a large fleet of stern-wheel steamboats which ran, during the summer, from the latter point to Dawson, Yukon Territory, and, from February to November, 1902, Mr. Lamont was engaged as Assistant Superintending Engineer of the River Division of the Railway Company on new construction work and the betterment of the boats in operation. Thus, it was a logical step in advance when, in October, 1902, he accepted the position of Port Engineer for the great fleet of the Pacific Coast Steamship Company, which has its headquarters at Seattle. He remained with this Company until March, 1904, having had the supervision of from 10 to 14 ocean-going ships, and showed much ability in obtaining the greatest efficiency in operation. Among the many devices for the transmission of power on vessels, which he worked out during this period, was an invention for absorbing the propeller shock on ships driven by screw propellers, which permitted an increase in speed without damage to the framework of the vessel.

Having to do with commercial affairs in his steamship work, he became attracted to pure business, and, during a portion of 1904, acted as Manager of the Seattle Branch of the Plant Rubber Supply Company. This experience resulted in the formation of the Pacific Engineering Company, of which he was President, having as his associates, G. Boschke, Assoc. M. Am. Soc. C. E., and Mr. Frank W. Hibbs, who had previously served as a Naval Constructor for the United States Navy Department. The firm was engaged in the supply business and also in general contracting, in which latter work, Mr. Lamont showed the greatest initiative and adaptability. Among the important contracts handled by the firm were the large ocean docks or wharves at Portland, Ore., for the Spokane, Portland, and Seattle Railway. This railway is commonly known as the North Bank Road, and is a low-grade line running from the East down the Columbia River into Portland, requiring the docks for handling its ocean commerce. This contract was carried out in a very efficient and skillful manner, and placed Mr. Lamont in the front rank of constructors in the Northwest.

In the meantime the Moran Shipbuilding Plant had been financed by Eastern capital, and had become the present great Seattle Construction and Dry Dock Company. Mr. Lamont was asked to return to its management, which he did in November, 1908, as Assistant to the President. The Company was handling about $2 000 000 worth of shipbuilding and ship repair work annually, and he assisted in a large way in building up the efficiency of the works to its present standing as one of the most dependable plants engaged in war-time shipbuilding. Mr. Lamont made many trips to Washington, D. C., in the interest of the Corporation and was successful in securing from the Government many large contracts for warships.

During this period many important engagements came to him as Consulting Engineer, including that of Trustees' Engineer for the White Pass and Yukon Route, and nothing speaks more in praise of his ability and energy than his re-employment by two great corporations for which he had previously worked. He resigned his position with the Seattle Construction and Dry Dock Company in 1915 and organized the firm of C. B. Lamont, Incorporated, for carrying out large projects and acting as consulting engineers. He was one of the organizers of the Skinner and Eddy Shipbuilding Corporation, of Seattle, one of the first firms to enter the business of building steel cargo vessels for the Allies, and, to a great extent, the wonderful records made by this firm were due to his ability and foresight.

He was engaged in such work in an energetic and forceful way up to the time of his death, and, although business occupied much of his time, he never failed to take great interest in public affairs and in social life. He was one of the organizers of the Seattle Hunt Club, and was a great horseback rider and a most enthusiastic sportsman and hunter. He was also a member of the Seattle Golf and Country Club, the Rainier Club, the Seattle Athletic Club, the Seattle Chamber of Commerce, the Union Club of Tacoma, Wash., and the Chevy Chase and Metropolitan Clubs of Washington, D. C.

Mr. Lamont was married in 1908 to Miss Maud Hahn, who survives him. Mrs. Lamont was a great help to her husband and shared in his leadership of many social affairs.

The best monument he has left behind is the unswerving regard of his business associates and the undying devotion of his friends. The Engineering Profession has suffered a distinct loss by his untimely death which came suddenly from pneumonia, on March 21st, 1918, in the busiest period of his life, when he was just past his forty-first birthday, and with his life a success:

> "For this is Art's true indication,
> When skill is minister to thought,
> When types which are the mind's creation,
> The hand to perfect form hath wrought."

Mr. Lamont was elected an Associate Member of the American Society of Civil Engineers on May 4th, 1909, and a Member on June 24th, 1914.

FRANKLIN BUCHANAN LOCKE, M. Am. Soc. C. E.*

DIED MAY 11TH, 1917.

Franklin Buchanan Locke was born at Hampton, N. H., on February 23d, 1857. He came of New England ancestry and was a lineal descendant of Captain John Locke, described as a man of prominent position among the early settlers of New Hampshire, who was killed by the Indians in 1696.

Franklin Buchanan Locke received his engineering education at the Massachusetts Institute of Technology, where he was a member of the class of 1877. He discontinued his course, after three years, however, to engage in the work of construction of the Hoosac Tunnel. His elder brother, the late Augustus W. Locke, M. Am. Soc. C. E., also an eminent engineer, was engaged on the same work, and, after the completion of the tunnel, became Superintendent of the Troy and Greenfield Railroad. Franklin Buchanan Locke was Assistant Engineer on the tunnel until 1881, at which time he formed a partnership with his brother, and the firm became known as perhaps the leading engineering firm of Western Massachusetts.

Mr. Locke's work was of great variety, covering the fields of railroad, municipal, and even mining, engineering. One of his earliest engagements was as Engineer for the extension of the water-works and drainage system of North Adams, Mass. He also had charge of the double-tracking of the State road east of the Hoosac Tunnel, and of the masonry.

In 1881-82 he was Principal Assistant Engineer on the Buffalo, Rochester and Pittsburg Railway, on that portion of the line between Salamanca, N. Y., and Ridgway, Pa. He did some valuable and interesting location work on the Mountain Division, south of Bradford, Pa., through a country parallel to the line of the Erie Railroad over the Kinzua Viaduct. He resigned this position, owing to poor health, and spent some time traveling in Europe, visiting most of the great Alpine tunnels and inspecting European railways. Returning to the United States, he became Engineer of Maintenance of Way of the Troy and Greenfield Railroad, which embraces the Hoosac Tunnel. He was also Chief Engineer of the Hoosac Valley Electric Railroad, which runs through Adams, North Adams, and Williamstown, Mass., and of a branch of the Fitchburg Railroad, which he constructed. He also investigated and reported on numerous railroad and mining properties in the West, and, for a time, was Engineer for the Michigan Hydraulic Mining Company in Idaho, as well as for some mines in Utah. With his brother, Mr. Locke became greatly interested in the problem of abolishing railroad grade crossings in Massachusetts, and was connected with projects for several works of this kind.

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* Memoir prepared by George F. Swain, Past-President, Am. Soc. C. E.

Finally settling in North Adams, Mass., he held the office of City Engineer for a number of terms, and also the office of Commissioner of Public Works; indeed, for many years, he was depended on to take the lead in the engineering work of the city. While in these positions, Mr. Locke had to do with the construction of water-works, sewers, roads, and bridges. He built many roads, and was an authority on their construction. He was, probably more than any one else, responsible for the successful recent extension of the North Adams Water-Works, which he planned and began.

One of Mr. Locke's most recent activities was in connection with the location and construction of the so-called "Mohawk Trail", a State road across the Berkshire Hills, between North Adams on the west and the Deerfield Valley on the east. Indeed, he was known in the vicinity of North Adams as "the Father of the Mohawk Trail". Although he started the movement for this road and surveyed a line, his route was not adopted by the State officials, although many considered it the best line; but, at any rate, Mr. Locke first conceived the idea of this trail.

He had traveled much in the United States and abroad, had assimilated his experience, and had gathered a great deal of knowledge. He had read widely and intelligently. Some people travel and read, but do not learn; Mr. Locke was not of this type. His breadth of interest was greater than that of most engineers. He had an artistic nature, and had even given some attention to art. He was modest, retiring, and, if he had any fault, it was that he did not push himself to the extent that his ability warranted, for he was really a man of fine perception, strong common sense, and exceedingly capable as an engineer. With greater stimulus, he might have made himself better known, and might have achieved a greater measure of what is usually, though probably mistakenly, termed success; but he preferred the quiet retirement of his home and the society of his friends and of his books, and, probably, after all, he derived in that way a greater measure of real satisfaction than falls to the lot of those who are more prominent or pushing in the battle of life. Mr. Locke was sociable, upright, hopeful, courageous, conscientious, and true. He had a high conception of the calling of the engineer, and no one could ever say that he had failed in his duties toward his fellow-men. He made many friends and lost few, and was beloved by all who knew him. His judgment was relied on by all who had had opportunity to test it, and his death has left a vacancy among his friends and in the engineering circles in which he moved, which will be difficult to fill. Even after his health became impaired, his advice was sought and relied on. In his home town, where his friends were legion, he will be sadly missed, but as long as a good water supply and the beauties of Nature are appreciated, his name will be held in affectionate remembrance.

Mr. Locke had been in failing health since 1907. He had never been extremely robust; nevertheless he continued to serve his State to the extent that his strength would permit. In 1914, when his health broke down and he had to give up public responsibility, he resigned as Commissioner of Public Works. A trip South benefited him for a time, but afforded no permanent relief, and he died, quite suddenly, in a hospital in Boston, Mass., when his friends thought he was out of danger.

He was a member of the American Institute of Mining Engineers, the Boston Society of Civil Engineers, the North Adams Club, and the Berkshire Club.

Mr. Locke was elected a Member of the American Society of Civil Engineers on March 1st, 1893.

WILLIAM McKELVEY MARPLE, M. Am. Soc. C. E.*

Died March 20th, 1918.

William McKelvey Marple, the son of the Rev. Abel Augustus and Harriet Neal (McKelvey) Marple, of Bucks County, Pa., was born in Wellsboro, Pa., on December 7th, 1852. His father was a clergyman of the Protestant Episcopal Church, and, in 1863, the family moved to Scranton, Pa., where, as Rector of St. Luke's Church until 1877, he was prominently identified with all the activities of that city and beloved by all who knew him.

William McKelvey Marple attended the public schools of Scranton, afterward studying Civil Engineering at Lehigh University.

In January, 1870, he was appointed Chainman and Rodman with the Engineering Corps of the Coal Department of the Delaware, Lackawanna and Western Railroad, under Mr. John F. Snyder. Later, he served, as Assistant Engineer, in the Railroad Department of the same road, under the late James Archbald, M. Am. Soc. C. E., Chief Engineer, on the construction of several new branches, among which was the Jessup and Winton Branch.

In July, 1879, Mr. Marple was employed as Division Engineer with the Chicago and Northwestern Railway, but resigned in January, 1880, to accept a position as Mining Engineer with the Franklin Iron Manufacturing Company of Clinton, N. Y.

From August to December, 1883, he was engaged on surveys for the Edgerton Coal Company and from February, 1884, to February,

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* Memoir prepared by Homer F. Cox, Chf. Engr. and Supt., The Scranton Gas and Water Company, Scranton, Pa.

1885, he was employed by the Delaware, Lackawanna and Western Railroad Company on surveys and office work.

In March, 1885, Mr. Marple began his service with the Scranton Gas and Water Company, first as Assistant on surveys, until December, 1886, then as Assistant Engineer on the construction of dams and reservoirs, and, finally, as Chief Engineer, which position he retained until he resigned on June 1st, 1913, to engage in private practice as a Consulting Engineer.

Under the broad and far-seeing plans of its President, the late W. W. Scranton, and by his twenty-eight years of honest, tireless, and conscientious work, and his energy, loyalty, and determination to keep pace with its engineering possibilities, Mr. Marple built and expanded this water system until, to-day, the City of Scranton possesses one of the finest of water supplies. The Water Company and its subsidiaries cover a territory which extends to Forest City, about 23 miles north of Scranton, and it was under Mr. Marple's direction, as Chief Engineer, that its largest dams were designed and constructed. Among these are the Curtis Dam (1886-87), Elmhurst Dam (1887-88), Williams Bridge Dam (1892-93), Burnt Bridge, or Lake Scranton, Dam (1898-99), and the Brownell Dam, at Carbondale, Pa. (1905-06). All are gravity dams of the best type of hydraulic masonry, equipped with the latest kinds of valves and with modern masonry gate and screen chambers.

In addition to this storage and distribution system, Mr. Marple located and built nearly 10 miles of macadam roads around the several reservoirs of the Water Company and to the summits of the water-shed, the Scrub Oak Drive reaching an elevation of 2 092 ft., thus giving to the public magnificent drives for their enjoyment.

In 1908, in order to make the supply of water to the city doubly sure, a tunnel, 7 by 9 ft. and 4 300 ft. long, was driven, under Mr. Marple's direction, in solid rock, through which a 48-in. supply pipe for conveying the water was laid. In 1909, it was found necessary to treat the water supply of Providence, a suburb of Scranton, as it came from an inhabited district of the water-shed, and a filter plant of the rapid sand gravity type, consisting of six units, each having a capacity of 1 000 000 gal., was constructed under Mr. Marple's supervision.

During his long service as Chief Engineer of the Scranton Water and Gas Company, Mr. Marple had associated with him, in a consulting capacity, such men as the late Alphonse Fteley and J. James R. Croes, Past-Presidents, Am. Soc. C. E., the late E. Sherman Gould, M. Am. Soc. C. E., and others of equal prominence.

Mr. Marple continued in private practice as a Consulting Engineer until he was compelled to retire in 1917 on account of failing health.

He had been confined to his bed for several months previous to his death, but was a patient sufferer at all times and most thoughtful toward all who cared for him. He died at his home in Scranton, Pa., on March 20th, 1918, and is survived by his wife, Mrs. Mary A. Marple, and one daughter, Mrs. Eugene C. Kelly, of Poughkeepsie, N. Y.

He was a Charter Member of the Scranton Engineers' Club, and always gave freely of his time and talents in the furtherance of its best interests. He had been twice honored by being elected its President, and just previous to his death had been made an Honorary Member. He was also a member of the American Water Works Association, the New England Water Works Association, and the American Gas Institute.

Aside from his professional associations, he was a member of the Peter Williamson Lodge, F. and A. M., the Knights Templars, and the Irem Temple. He also took a most active part in church work as a member of St. Luke's Protestant Episcopal Church, having served as a Vestryman for 16 years.

Mr. Marple was elected a Member of the American Society of Civil Engineers on June 4th, 1890.

ALFRED BOARDMAN MAYHEW, M. Am. Soc. C. E.*

DIED MAY 12TH, 1918.

Alfred Boardman Mayhew was born at Heath, Mass., on September 3d, 1878. He was graduated from Tufts College in 1904, with the degree of B. S. in Civil Engineering.

His earliest engineering work was on the construction of two dams for power development, one at Gavins Fall, N. H., and one at Dorchester, Mass.

In June, 1905, Mr. Mayhew entered the employ of the United States Reclamation Service, and occupied various responsible positions connected with the design and construction of large irrigation projects in the West, principally the Minidoka and the Boise Projects in Idaho. He was Resident Engineer on the construction of several important sections of main canal, including diversion dams, bridges, and other large structures providing for cross-drainage, railroad crossings, lateral outlets, etc.

When the construction of the Arrowrock Dam (the highest dam in the world) was authorized, Mr. Mayhew was selected as Principal Engineering Assistant to the Construction Engineer, and had direct charge of the field engineering and designs. He was personally responsible for many of the details of the design of that dam and related structures, and was closely identified with the construction until it was nearly finished.

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* Memoir prepared by Charles H. Paul and F. C. Horn, Members, Am. Soc. C. E.

In November, 1914, Mr. Mayhew was given a furlough by the Reclamation Service, in order that he might accept a position with The Morgan Engineering Company, at Dayton, Ohio, on studies and plans for flood-prevention works in the Miami Valley, and he continued on that work as an employee of The Miami Conservancy District, after the formation of the District under the Conservancy Act of Ohio. He took a prominent part in the preparation of the designs, specifications, and estimates for the whole project, and, when construction started, was given charge of the Germantown Dam, as Division Engineer. It was while directing the work of raising a suspension bridge above the reach of flood-waters, at this dam, that Mr. Mayhew was thrown into the river and drowned on May 12th, 1918.

Mr. Mayhew's fine personality, coupled with his well-balanced capabilities as an engineer, gained for him the respect and confidence of all with whom he was associated. He was not only a good engineer, but also a good citizen, and took a lively interest in the affairs of the day.

He was married, on September 14th, 1911, to Miss Maude O. Greene, of Princeton, Ill., who survives him.

Mr. Mayhew was elected an Associate Member of the American Society of Civil Engineers, on November 8th, 1909, and a Member on January 18th, 1916.

MARSHALL POPE ROBERTSON, M. Am. Soc. C. E.*

Died November 2d, 1917.

Marshall Pope Robertson was born at Baton Rouge, La., on April 26th, 1861. He received his early education in the Parish of East Baton Rouge, and was graduated, in 1882, from the Louisiana State University and the Agricultural and Mechanical College, at Baton Rouge, La.

During his summer vacations in 1881 and 1882, Mr. Robertson was employed as Rodman and Resident Engineer on construction, on the Texas and Pacific Railroad.

From 1883 to 1894, he served as City Surveyor of Baton Rouge, La. While in this position, he was also engaged on work for the United States Government, as Engineer in charge of the construction of roadways to the Military Cemeteries at Port Hudson, La., Corinth, Miss., and Marietta, Ga., from 1889 to 1891, and as United States Surveyor for the Lower Texas District, on levees from Vicksburg, Miss., to the mouth of the Red River.

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* Memoir prepared by the Secretary from information on file at Society Headquarters.

In August, 1896, he was appointed an Assistant to the Board of State Engineers of Louisiana, which position he retained until August, 1900, when he was appointed Assistant State Engineer and Member of the Board of State Engineers. From 1900 to 1902, Mr. Robertson had charge, for the State, of levees and canals on the Red River and, from 1902 to 1908, he was in direct charge of work on the Mississippi River and on levees on the Arkansas and Mississippi Rivers.

From 1908 to 1912, he was engaged in the private practice of engineering of an extensive and varied character. In 1912, he was again appointed a Member of the Board of State Engineers and served in that capacity continuously until his death on November 2d, 1917.

Mr. Robertson was honorable, capable, and conscientious in the discharge of his duties, to which he brought to bear the faculty of a good judgment acquired by the experience of many years, and, at the time of his death, the Board of State Engineers, of which he was for so long a member, passed resolutions expressing its appreciation of his valuable services and its sorrow at the loss sustained by his family and by the State.

Mr. Robertson was elected an Associate Member of the American Society of Civil Engineers on March 5th, 1902, and a Member on September 4th, 1906. He was also a Charter Member of the Louisiana Engineering Society.

EDWIN AUGUSTUS STEVENS, M. Am. Soc. C. E.*

DIED MARCH 8TH, 1918.

Edwin Augustus Stevens, head of the Stevens family of Castle Point, Hoboken, N. J., famous for its administrative and engineering achievements during a century and a quarter of continued activity, and a son of the founder of Stevens Institute of Technology, died on March 8th, 1918, of pneumonia, at Washington, D. C., where he was serving as a field officer of the Emergency Fleet Corporation.

Edwin Augustus Stevens was born in Philadelphia, Pa., on March 14th, 1858. He was educated at St. Paul's School, Concord, N. H., and at Princeton University, from which he was graduated in 1879.

He entered the employ of the Hoboken Land and Improvement Company which controlled the interests of the Stevens family in Hoboken, and, in 1885, was elected President, which office he held until his death. He was also President of the Hoboken Ferry Company, operating ferries from Hoboken to Barclay, Christopher, 14th and 23d Streets, in New York City, from 1885 to 1896, when the company was sold to other interests and later acquired by the Delaware, Lackawanna and Western Railroad, by which the ferries are now operated. He was also a Director of the First National Bank of Hoboken, the Hudson Trust Company, the Commercial Trust Company, and of the Niagara Fire Insurance Company.

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* Memoir prepared by Professor F. DeR. Furman.

Descended from a family of pioneer engineers—his grandfather, John Stevens, having invented and built a steamboat that operated on the Hudson River in 1804, and a locomotive that operated on a track in Hoboken in 1826; his uncle, Robert L. Stevens, having invented, in 1830, the present form of T-rail used in railroad track construction and having entered into a contract with the United States Government, in 1842, for the construction of the first armor-clad "war steamer"; and his father having invented, in 1832, the air-tight fireroom used in warships and in some merchant ships—Edwin Augustus Stevens had a strong inclination for engineering, and devoted much of his available time to technical subjects. Early in his career, he engaged in engineering work connected with the Hackensack Water Company, supplying the City of Hoboken. He was next interested in the development of high-speed engines and machine tools, and, later, achieved notable distinction in the design of the ferry-boat *Bergen,* built in 1889. This was the first ferry-boat to be fitted with screw propellers. It marked a signal departure in the construction of such vessels and proved so satisfactory that it has been generally adopted in place of the paddle-wheel construction, in this class of service. Subsequently, Mr. Stevens was engaged as Consulting Engineer by the City of New York in the matter of the construction of the Staten Island ferry-boats, and was also in charge of the design of ferry-boats for the Delaware, Lackawanna and Western Railroad Company. He was a member of the firm of Cox and Stevens, of New York City, Naval Architects and Marine Engineers, from 1905 to 1909. In 1905, Stevens Institute of Technology, of which he was a Trustee at the time of his death, conferred on him the honorary degree of Doctor of Engineering.

He was also active in civic and State matters, having served as Park Commissioner, Tax Commissioner, and as a member of the Commission which settled the long-standing dispute regarding the boundary between New Jersey and New York. He was also Chairman of the New Jersey Commission of the Interstate Palisades Park Commission. He was a Democrat in politics and served as Presidential elector in the campaigns of 1888 and 1892, when President Cleveland was the Democratic candidate.

Mr. Stevens became Adjutant of the old Ninth Regiment of the New Jersey National Guard in 1880, served later on the staff of Governor Ludlow, and, in 1884, became Colonel of the old Second Regiment. He retained this command for eight years. In 1911, President Wilson, then Governor of New Jersey, appointed him Commissioner of Highways for the State. He was re-appointed by Governor Fielder in 1914 and served in this capacity for a total of six years, when the State laws were revised and the Road Department was placed under a Highway Commission composed of eight men, of which Col. Stevens was one of the original appointees and one of the members at the time of his death.

With all his activities, he was a devoted Churchman, having served as a Vestryman of the Church of the Holy Innocents in Hoboken, Treasurer of the Protestant Episcopal Diocese of Newark, and Trustee of the Episcopal Fund and Diocesan Properties. He was also frequently in attendance as a delegate to the General Convention of the Protestant Episcopal Church.

Col. Stevens was married to Emily C. Lewis, who survives him, together with seven children: John, Edwin A., Jr., Washington L., Bayard, Basil M., Lawrence L., and Emily Lewis Stevens. Of these, Edwin A. Stevens, Jr., is a naval architect and marine engineer and is at present with the United States Shipping Board, Emergency Fleet Corporation. He has also been appointed to fill the vacancy left by his father as member of the Board of Trustees of Stevens Institute of Technology. Two other sons are in Government service, Washington Lewis Stevens as a Lieutenant in the National Army, and Basil M. Stevens as a Lieutenant in the Officers Reserve Corps.

Col. Stevens was associated with numerous organizations, always serving prominently as presiding officer, author, or active member. He was one of the Founders of the Society of Naval Architects and Marine Engineers, and, later, served as a Vice-President; President of the American Road Builders Association; member of the Institution of Naval Architects; Life Associate of the American Society of Mechanical Engineers; member of the American Society of Naval Engineers; American Society for Testing Materials; Army League of the United States; National Marine League of the United States of America; Engineers' Club of New York City; Engineers' Club of Trenton; National Geographic Society; Historical Society of Hudson County; Princeton Club of New York; Essex Fox Hounds Riding Club; and Somerset Hills Country Club.

Among the contributions of Col. Stevens to technical literature are the following: "Performances of the *Bergen* and *Orange* Steam Ferry-Boats",* written in conjunction with Professor J. E. Denton; "Screw Ferry-Boats";† "Ferry-Boat Performances";‡ "Tidal Corrections",§ written in conjunction with Mr. C. P. Paulding; "Application of Taylor's Analysis to the Performance of the Ferry-Boat *Cincinnati,"*[*] written in conjunction with Mr. Paulding; "Progressive Trials of the Ferry-Boat *Edgewater,"*[†] written in conjunction with Mr. Paulding; "Progressive Trials of the Ferry-Boat *Bremen"*;[‡] "Screw Ferry-Boats";[§] "American Competition";[||] "The Future of Good Roads in State and Nation".[¶]

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* *Transactions,* Am. Soc. Mech. Engrs., Vol. 11 (1890), p. 372.

† *Transactions,* Soc. of Naval Archts. and Marine Engrs., Vol. 1 (1893), p. 192.

‡ *Stevens Institute Indicator,* 1900.

§ *Transactions,* Soc. of Nav. Archts. and Marine Engrs., Vol. 9 (1901), p. 235.

Col. Stevens was elected a Member of the American Society of Civil Engineers on June 3d, 1915.

BERNARD MATTHEW WAGNER, M. Am. Soc. C. E.[**]

DIED JUNE 15TH, 1918.

Bernard Matthew Wagner, the son of Bernhard and Pauline Wagner, was born on September 9th, 1868, at St. Gall, Switzerland. He was brought to the United States as a child, and was educated in the public schools of New York City, taking the degree of Bachelor of Science at Cooper Institute in 1888. Thereafter, he returned to Switzerland, and entered the Swiss Federal Polytechnic, at Zurich, from which he was graduated as Ingenieur in 1892. He then became Assistant to M. E. Paschaud, Engineer of the Swiss Occidental Railroad, and was engaged in survey and office work on that system. Later, he was Assistant to the Chief Engineer of the Grand Ducal Railroad, in which position he was engaged on bridge and construction work. Mr. Wagner also served for a short time as Draftsman in the Raub Locomotive Works.

In 1894, he returned to the United States and, in 1895, entered the service of the Department of Water Supply of New York City. He was appointed Assistant to I. M. de Varona, M. Am. Soc. C. E., Chief Engineer of the Brooklyn Water Department, and continued in the employ of the city until 1912.

During his seventeen years of municipal service, Mr. Wagner was engaged on the important and extensive construction work carried out by Mr. de Varona, notably the large steel main extending from Jamaica to Ridgewood, planning and drawing specifications for mains and standpipe work, and designing and erecting new steam-generating plants and pumping plants at Mount Prospect and Baldwin, Long Island. Later, he was placed in charge of filter-plant construction and maintenance, and supervised the planning and construction of the mechanical filter plants at Jameco, and Springfield, Long Island.

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[*] *Stevens Institute Indicator,* 1901.

[†] *Transactions,* Soc. of Nav. Archts. and Marine Engrs., Vol. 10 (1902), p. 15.

[‡] *Transactions,* Soc. of Nav. Archts. and Marine Engrs., Vol. 11 (1903), p. 1.

[§] *Cassier's Magazine,* Vol. 6 (1894), p. 275.

[||] *Engineering* (London), 1899.

[¶] *Scribner's Magazine,* February, 1916.

[**] Memoir prepared by Reginald Pelham Bolton, M. Am. Soc. C. E.

After leaving the service of the city, Mr. Wagner became associated with the R. P. Bolton Company, and took part in the preparation of the Citizens' Plan for the New York Central West Side Improvement, and in plans for power and hydro-electric machinery.

On the outbreak of the Spanish War in 1898, Mr. Wagner was a member of the Twelfth Regiment, New York National Guard, and, during his service with that regiment in the war, he did much effective work as a field officer, in which capacity his ability as a civil engineer was of special value in connection with cantonment details. He left the service with the rank of Captain.

On the entry of the United States into the present war, Captain Wagner immediately volunteered his services in the Reserve Corps, and was given a commission as Major. His health, however, precluded his taking part in active service, and in the winter of 1917, he was compelled to resign his commission. He thereupon devoted himself to shipyard and ship planning, in which he was engaged at the time of his death.

Major Wagner, whose amiable character, high integrity, and great engineering ability had endeared him to his employers, his associates, and to his wide circle of friends, had made his home in Brooklyn, N. Y., for many years. He was married there in 1898, and his body has been laid to rest in Greenwood Cemetery. He is survived by his widow and one daughter.

Major Wagner was elected an Associate Member of the American Society of Civil Engineers on May 3d, 1899, and a Member on December 1st, 1903.

JOHN WATERHOUSE, M. Am. Soc. C. E.*

Died February 20th, 1918.

John Waterhouse was born in Bucks County, Pa., on October 4th, 1839. His father, Ingham Waterhouse, came from Kingwood, N. J., where the family had settled on arriving from England. His mother, Frances Calvin Waterhouse, who was born in Bucks County, Pa., was a daughter of Joshua B. Calvin, at one time a member of the Pennsylvania Legislature, and a direct descendant of John Calvin the reformer. Another ancestor, Dr. Benjamin Waterhouse, who was born in Newport, R. I., was a prominent surgeon in the Continental

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* Memoir prepared by H. I. Latimer, Esq., and Robert Ridgway, M. Am. Soc. C. E.

Army, and was said to have been the physician who introduced vaccination in America. He taught in Harvard College from 1783 to 1812, as Hersey Professor in theory and practice of physics.

At the age of eleven, John Waterhouse was a boat boy on the Delaware Division of the Pennsylvania Canal. Later, during his school years, he worked on a farm, and was employed for four years in mercantile work at Lambertville, N. J., until he was twenty. On the breaking out of the Civil War, he enlisted in the Third Regiment of New Jersey, and, on the completion of his three months' term of enlistment, went into business with his brother in Trenton, where he remained about a year.

Mr. Waterhouse began his engineering career in 1863 when he went to Pittsburgh, Pa., and joined the engineering force of the Pittsburg and Steubenville Section of the Pennsylvania Railroad as an Axeman and Rodman, being transferred later to the Lewiston Branch of the same railroad. He spent some time in Oil City, Pa., soon after the outbreak of the oil fever there, as a Surveyor, but illness obliged him to give up these activities, and he went West, entering the service of the Missouri Pacific Railroad as a Transitman. From 1865 to 1867, he was Assistant Engineer of that railroad at Kansas City, and Principal Assistant Engineer on the Kansas City and Camaron Railroad. During 1867 and 1868, he was in charge of the Tunnel Division of the west shore, North Missouri Railroad, at Liberty Landing, Mo. From 1868 to 1869, he was employed as Division Engineer with the Kansas City, Fort Scott and Gulf Railroad, at Paola, Kans., and, in 1869 and 1870, as Principal Assistant on surveys through Indian Territory for the same railroad. From then until the latter part of 1872, he was at Lebanon, Mo., as Principal Assistant Engineer for the Laclede and Fort Scott Railroad. During 1872 and 1873 he made surveys for, and located the railroad connection to, the Breen Iron Mine, southwest of Escanaba, Mich., for the Chicago and Northwestern Railway. Following this, he was in the service of the United States Government until 1874, on surveys of the Mississippi and Osage Rivers, with station at St. Louis, Mo., and, from 1874 to 1876, was Chief Engineer of the Paris and Danville Railroad in Illinois.

In 1877, Mr. Waterhouse came to New York City, and, on the recommendation of William F. Shunk, the Chief Engineer, he accepted an appointment as Assistant Engineer with the New York Loan and Improvement Company, which company was then constructing the elevated railroad on Sixth Avenue for the Metropolitan Elevated Railway Company. The Sixth Avenue line was one of four lines of rapid transit elevated railroads then under construction in the city, the others being known as the Second Avenue, Third Avenue, and Ninth Avenue lines. The Second Avenue and Sixth Avenue lines were controlled by the Metropolitan Company, the other two by the New York Elevated

Railroad Company, but on September 1st, 1879, all these properties were taken over for operation by the Manhattan Railway Company. Mr. Waterhouse resigned his position with the latter Company on July 1st, 1881, but was re-appointed Assistant Engineer on May 13th, 1882. Thereafter, he continued in its service until March 1st, 1899. On August 1st, 1885, he was promoted to the grade of Principal Assistant Engineer, and on March 1st, 1890, was made Chief Engineer of the Company. In January, 1899, he retired as Chief Engineer, and on January 23d, he was made Consulting Engineer, resigning this position on March 1st, 1899, after practically 22 years of service on the construction and maintenance of this extensive system of elevated railroads, about one-half of their life. The records of the Chief Engineer's office are replete with evidences of his conscientious personal attention to details and of his skill as an Engineer. At the time of his retirement as Chief Engineer, the system operated by the Manhattan Railway Company, comprised 32 miles of elevated railroad structures, or 107 miles of single track. This system included not only the original four lines on Manhattan Island, but the connecting line north of the Harlem River in what is now the Borough of the Bronx, which was constructed by and leased from the Suburban Rapid Transit Company.

Mr. Waterhouse was in direct charge of the construction of the Western Division of the Metropolitan Lines extending from 83d Street on Ninth (now Columbus) Avenue to 155th Street on Eighth Avenue. This extension was built in 1878 and 1879, and included the famous 110th Street reverse curve, the highest elevated railway structure for urban service in the world, its maximum height from the street surface to the base of rail being 60 ft. Later, as Chief Engineer, he personally designed the present four-track structure on West Broadway between Chambers and Franklin Streets, known as the "West Broadway Pocket." The design of this pocket was discussed and criticized at the time by a number of engineers and architects, but was built according to Mr. Waterhouse's plan. The fact that it still remains in use after nearly thirty years of constant service indicates the designer's good judgment and skill.

Mr. Waterhouse was always methodical and simple in his tastes and habits, and if it could be said that he had any hobbies, they were good books, mathematics, and inventions. Some years ago, he originated a method for proving the Pythagorean theorem in geometry, which was published in the *Scientific American,* and which interested instructors of geometry all over the country, bringing many letters of commendation to him from prominent teachers. Faithful to his duties and loyal to his superiors, he enjoyed the respect as well as the affection of his many subordinates. Perhaps he was lacking in aggressiveness, but in his gentle, quiet way he was convincing, and the friends he made were life-long. Those who knew him loved him, and, to his intimates, he was regarded as one of God's noblemen.

More than ten years ago Mr. Waterhouse became totally blind and deaf, but he bore his terrible affliction with the characteristic cheerfulness for which he was noted, occupying much of his time in reading books for the blind, the intricacies of which he mastered within a week and without instruction. During this period he invented a very ingenious writing board which enabled the user, by the sense of touch, to write in a natural hand, keep to straight lines, observe the required spaces between them, number the sheets as finished, and record them in consecutive order. Mr. Waterhouse used this board for several years with great success.

In 1872, he was married to Miss Letitia Southwick, who died in 1873. He is survived by his daughter, Miss Pearl Frances Waterhouse, of New York City. The bond between father and daughter was an unusually close one, and she was his constant companion during the years of his affliction.

Mr. Waterhouse was elected a Member of the American Society of Civil Engineers on October 4th, 1899.

JOEL MANNING HOWARD, Assoc. M. Am. Soc. C. E.*

Died May 25th, 1917.

Joel Manning Howard was born in Ogdensburg, N. Y., on April 24th, 1880. His early education was obtained in the public schools of that city, and he was graduated from the Ogdensburg Free Academy. He then entered the Mechanical Engineering Course at Clarkson College of Technology, at Potsdam, N. Y., from which he was graduated in 1902, with the degree of B. S.

Immediately after his graduation, Mr. Howard entered the service of the United States Lake Survey, where he was engaged on the topographic and hydrographic survey of the St. Lawrence River. Upon leaving the Government service, he was employed by the Barber Asphalt Paving Company, and afterward had charge of the water-proofing of the subway tunnels in New York City, for the Sicilian Asphalt Paving Company.

In June, 1907, Mr. Howard received an appointment from the State Engineer of New York, and was assigned to take charge of contracts in Oswego County. In 1909, he was transferred to work in St. Lawrence County, and had complete charge of all the State road work of that County. He held this position until 1913, when he was appointed County Superintendent of Highways by the Board of Supervisors of St. Lawrence County, which position he held until his death.

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* Memoir prepared by Charles A. Pohl, M. Am. Soc. C. E.

Mr. Howard was recognized by all who knew him as a man of splendid character and high ideals, which, together with conscientious service and interest in his profession, his community, and public affairs, made him a valuable public servant.

He is survived by his wife, who was Miss Gertrude Crapser, of Waddington, N. Y., and two sons. He was a member of Acacian Lodge, F. and A. M., and the Century Club, of Ogdensburg, N. Y.

Mr. Howard was elected an Associate Member of the American Society of Civil Engineers on June 4th, 1913.

CLARK WALLACE THOMPSON, Assoc. M. Am. Soc. C. E.*

Died March 16th, 1918.

Clark Wallace Thompson was born at St. Paul, Minn., on August 27th, 1866. His father was the late Clark W. Thompson who was Superintendent of Indian Affairs under President Lincoln. The family moved to La Crosse, Wis., and it was here that Mr. Thompson grew to manhood. He was educated in the public schools of that city and was graduated from the High School. He then entered Rensselaer Polytechnic Institute, at Troy, N. Y., from which he was graduated in 1887 with high honors as a Civil Engineer.

He began his engineering work in the fall of 1887 as a Draftsman with the "Soo" Railroad Company, at Minneapolis, Minn., resigning to go to the Duluth and Iron Range Railroad Company as Assistant to the Resident Engineer on construction work.

During the summer and fall of 1888 Mr. Thompson was Engineer in charge of the construction of a submerged water main connecting the Duluth and West Superior Water-Works, as well as a pump-house intake pipe and crib for the Superior Water-Works.

In 1889, he was engaged on water-works construction in North St. Paul, Minn., and also at Duluth, Minn., where he supervised and built a storage reservoir and gas-holder for the Duluth Gas and Water Company. In 1890, Mr. Thompson went to Lakeside, Minn., where he was employed on the construction of the water-works. He was also engaged on the building of gas-works for the Duluth Gas and Water Company.

In 1891, he returned to La Crosse, Wis., where he opened an office as a Consulting Engineer. Later, he became associated with the

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* Memoir prepared by the Secretary from information on file at the Headquarters of the Society.

S. Y. Hyde Elevator Company, and designed and built several grain elevators. In 1893 he was elected Treasurer of that Company, which position he retained until 1901, when he moved to Cascade Locks, Ore., to undertake the management of the Wind River Lumber Company. He designed and built that Company's lumber mill, said to be one of the best on the Pacific Coast, and the structures for driving and flooding the streams to which the timber of the Company is tributary.

Mr. Thompson had been in poor health for a year or more, from heart trouble. In the fall of 1917, in the hope that the mild climate of Southern California might benefit him, he went to Los Angeles, Cal., where he died on March 16th, 1918.

In 1892, Mr. Thompson was married to Miss Jessie M. Hyde, the eldest daughter of the late S. Y. Hyde, of La Crosse, Wis., who with seven children, survives him.

During his residence in La Crosse, he took an active part in public affairs, and, as a member of the City Council, had given efficient and loyal service, especially in problems in which his engineering experience was of value. He was known on the Pacific Coast as a clever engineer, and his many friends will remember him as a loyal fellow citizen, a generous host and friend, and for all the qualities that go to make a lovable character.

Mr. Thompson was elected a Junior of the American Society of Civil Engineers on March 5th, 1890, and an Associate Member on July 3d, 1895.

PAPERS AND DISCUSSIONS CURRENT IN PROCEEDINGS

Final Report of the Special Committee on Concrete and Reinforced Concrete........Dec., 1916
Discussion....Feb., Mar., Apr., May, Aug., Sept., Oct., 1917, Jan., Feb., Aug., 1918

"Cement Joints for Cast-Iron Water Mains." CLARK H. SHAW........Mar., 1917
Discussion........May, Aug., "

Progress Report of the Special Committee to Codify Present Practice on the Bearing Value of Soils for Foundations, etc........Aug., "
Discussion........Nov., "

"Detention Reservoirs with Spillway Outlets as an Agency in Flood Control." H. M. CHITTENDEN........Sept., "
Discussion........Nov., Dec., 1917, Jan., Feb., May, Aug., 1918

"The Hell Gate Arch Bridge and Approaches of the New York Connecting Railroad Over the East River in New York City." O. H. AMMANN....Oct., 1917
Discussion. (Author's closure.)....Dec., 1917, Jan., Mar., Apr., Aug., 1918

"Stress Measurements on the Hell Gate Arch Bridge." D. B. STEINMAN...Oct., 1917
Discussion. (Author's closure)..Dec., 1917, Jan., Feb., Mar., Apr., Aug., 1918

"The Activities of the American Society of Civil Engineers During the Past Twenty-five Years." CHAS. WARREN HUNT........Dec., 1917
Discussion........Mar., 1918

"Ice Diversion, Hydraulic Models, and Hydraulic Similarity." BENJAMIN F. GROAT........Dec., 1917
Discussion. (Author's closure.)........Feb., Mar., Aug., 1918

Final Report of the Special Committee on Steel Columns and Struts........Dec., 1917
Discussion........Feb., Mar., Apr., Aug., 1918

Progress Report of the Special Committee on the Regulation of Water Rights.Dec., 1917
Discussion........Feb., 1918

"Verification of the Bazin Weir Formula by Hydro-Chemical Gaugings." FLOYD A. NAGLER........Jan., "
Discussion........Mar., May, Aug., "

"Determination of the Duty of Water by Analytical Experiment." W. C. HAMMATT........Feb., "
Discussion........Apr., "

"The Economics of Steel Arch Bridges." J. A. L. WADDELL........Mar., "
Discussion........May, Aug., "

"Construction Methods Used in Building the Lower Reservoir Dam of the Balmorhea Project." VERNON L. SULLIVAN........Apr., "

"Improving Arch Action in Arch Dams." L. R. JORGENSEN........May, "
Discussion........Aug., "

"Emergency Construction Work Due to War Conditions. With Especial Reference to the Construction Division of the Army." GEORGE W. FULLER........May, "

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AMERICAN SOCIETY

OF

CIVIL ENGINEERS

VOL. XLIV—No. 7

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PROCEEDINGS

OF THE

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OF

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(INSTITUTED 1852)

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ON THE REGULATION OF WATER RIGHTS: F. H. Newell, W. C. Hoad, John H. Lewis.

TO REPORT ON STRESSES IN RAILROAD TRACK: A. N. Talbot, A. S. Baldwin, G. H. Bremner, John Brunner, W. J. Burton, Charles S. Churchill, W. C. Cushing, Robert W. Hunt, George W. Kittredge, Paul M. LaBach, C. G. E. Larsson, G. J. Ray, Albert F. Reichmann, H. R. Safford, F. E. Turneaure, J. E. Willoughby.

◆

The Reading Room of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

HEADQUARTERS OF THE SOCIETY—33 WEST THIRTY-NINTH STREET, NEW YORK.

TELEPHONE NUMBER....................4600 Vanderbilt.
CABLE ADDRESS......................"Ceas, New York."

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* Director William R. Hill died June 16th, 1918.

Vol. XLIV. SEPTEMBER, 1918. No. 7.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PROCEEDINGS

This Society is not responsible for any statement made or opinion expressed in its publications.

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MINUTES OF MEETINGS

OF THE SOCIETY

September 4th, 1918.—The meeting was called to order at 8.30 P. M.; Vice-President Kittredge in the chair; Chas. Warren Hunt, Secretary; and present, also, 215 members and 40 guests.

The minutes of the meetings of May 15th and June 5th, 1918, were approved as printed in *Proceedings* for August, 1918.

J. de B. W. Gardiner, Assoc. M. Am. Soc. C. E., formerly an officer in the United States Army, and at present Military Expert for *The New York Times,* addressed the meeting on "The Military Operations of 1918", illustrating his remarks with lantern slides.

The Secretary announced that the Board of Direction, at its meeting of April 16th, 1918, had adopted the following resolutions:

"*Resolved:* That regular business meetings of the Society be held, as required by the Constitution, on the first Wednesday of each month except during July and August, and that at these meetings, in addition to the regular business, professional papers previously published shall be presented for discussion.

"*Resolved:* That, at the meetings held on the third Wednesday of the month, the programme of papers, addresses, or discussions, shall be placed in the hands of a Committee of seven resident members to be appointed by the Executive Committee and to be known as the New York Meetings Committee, this Committee to be charged with the entire responsibility for the conduct of these meetings."

In conformity with these resolutions, the Executive Committee has appointed the following committee:

CLIFFORD M. HOLLAND, *Chairman,*
J. B. FRENCH,
ARTHUR W. TIDD,
J. O. ECKERSLEY,
E. N. LAYFIELD,
E. B. BESSELIEVRE,
CHARLES GILMAN.

Paul G. Brown, M. Am. Soc. C. E., addressed the meeting briefly on the subject of reconstruction after the war, and Robert Ridgway, M. Am. Soc. C. E., offered the following resolution:

"*Resolved:* That this meeting is of the opinion that the Board of Direction should provide for a committee whose functions shall be to keep itself and the Board informed of any Governmental or other programme looking to the reconstruction or rehabilitation, after the war, of the engineering resources of the country, and to advise the Board of such action as it should take in the premises (from time to time) to the end that such resources may be conserved."

On motion, duly seconded, the resolution was carried.

The Secretary announced the following deaths:

CALVIN HARLOW ALLEN, of New York City, elected Member, September 7th, 1887; died July 14th, 1918.

HOWARD LINCOLN COBURN, of New York City, elected Member, March 5th, 1912; died June 19th, 1918.

WILLIAM RYAN HILL (*Director*), of Albany, N. Y., elected Member, July 1st, 1891; died June 16th, 1918.

CHARLES ARTHUR LINDBERY, Capt., Engr. R. C., of Camp Laurel, Md., elected Member, October 1st, 1913; died at Camp Lee, Va.; date of death unknown.

ROBERT EMMET MCMATH, of St. Louis, Mo., elected Member, March 3d, 1880; date of death unknown.

EDGAR MARBURG, of Philadelphia, Pa., elected Member, October 6th, 1897; died June 27th, 1918.

Augustus Mordecai, of Cleveland, Ohio, elected Member, February 1st, 1893; died July 28th, 1918.

John Warren Sackett, of Jacksonville, Fla., elected Member, May 2d, 1894; died July 3d, 1918.

Arnold Henry Sutermeister, of Albany, N. Y., elected Member, June 3d, 1902; died June 29th, 1918.

Bernard Matthew Wagner, of Brooklyn, N. Y., elected Associate Member, May 3d, 1899; Member, December 1st, 1903; died June 8th, 1918.

Leslie Abram Waterbury, of Nitro, W. Va., elected Associate, November 7th, 1906; Associate Member, June 30th, 1910; Member, September 3d, 1913; died June 15th, 1918.

Frederick William Watkins, of New York City, elected Member, October 3d, 1883; died August 20th, 1918.

Robert Stuart Armstrong, of New York City, elected Associate Member, February 6th, 1907; died July 15th, 1918.

William Blair Bovyer, of San Francisco, Cal., elected Junior, October 1st, 1913; Associate Member, September 12th, 1916; died July 20th, 1918.

John Bonaventure Murray, of New York City, elected Associate Member, September 6th, 1910; died August 10th, 1918.

Rutledge Irving Odell, of Tomkins Cove, N. Y., elected Associate, October 1st, 1895; died March 25th, 1918.

Adjourned.

ELECTIONS AND TRANSFERS BY THE BOARD OF DIRECTION
SEPTEMBER 10th, 1918.

Elected as Members

Horace Prentiss Boardman, Nitro, W. Va.
William Goedecke, New York City
Clair Allen Inskeep, Bellefontaine, Ohio
Howard Fay Passel, Indianapolis, Ind.
Theodore Hobart Skinner, Muscle Shoals, Ala.
Harry Matthew Steward, Boston, Mass.
Edward Ahlert Stuhrman, Atlanta, Ga.
Ernest William Taylor, Cleveland, Ohio
Benjamin Franklin Tillson, Franklin, N. J.
Roswell Delmege Trimble, Richmond, Va.

Elected as Associate Members

Kenneth Bliss Allen, Dayton, Ohio
Charles Chambers Armstrong, Newark, N. J.
Thomas Sneed Byrne, Sheffield, Ala.

GEORGE WALLIS CARR, JR., West Palm Beach, Fla.
DANIEL WARWICK COLHOUN, Am. Exp. Forces, France
JOHN FREDERICK WILLIAM CRONEMEYER, Badin, N. C.
WILLIAM HENRY CROSSON, 2d Bn., 20th Engrs., France
NORMAN ENGLE DAVIS, Glens Falls, N. Y.
JUAN ISIDORE DEJONGH, Guatemala City, Guatemala
RAYMOND ROWE EAGLE, New Berne, N. C.
ARTHUR DONALD EDMONSTON, Camp Lee, Va.
CLIFFORD ROBERT FULTON, Lincoln, Nebr.
JOSÉ ANTONIO GÓMEZ GAULT, Quito, Ecuador
ROY FRANK HALL, Utica, N. Y.
JOHN ALLAN HARRINGTON, Milwaukee, Wis.
JAMES CAROTHERS HARVEY, Los Lunas, N. Mex.
CHARLES GOTTLOB HOERNER, JR., Phœnicia, N. Y.
JOHN GEORGE HOLLMAN, New Orleans, La.
RALPH WARREN HORNE, Malden, Mass.
SIDNEY MERRILL HOYT, Kansas City, Mo.
HARRY ABE HYMAN, New York City
JAMES NORMAN IRVING, Los Angeles, Cal.
SIGURD STEEN JOHNSEN, Havana, Cuba.
ALFRED LAWRENCE KEHOE, JR., New York City
LOUIS JOHN KILLION, Boston, Mass.
WILLIAM CARLTON MCNAUGHTON, West Englewood, N. J.
MARTIN JOHN MCPIKE, Brooklyn, N. Y.
CHAUNCEY ARTHUR PIERCE, Brooklyn, N. Y.
WILLIAM REECE PLEW, Bozeman, Mont.
ELWIN HARRIS QUINNEY, Pierre, S. Dak.
CHARLES ALLEY REED, Oakland, Cal.
RALPH ALEXANDER ROLLO, Murphysboro, Ill.
LLOYD MCCREIGHT ROSS, Charlotte, N. C.
JOHN MARVIN RYDER, Schenectady, N. Y.
CARROLL CRAWFORD SPRIGG, New York City
EDWIN QUINBY SULLIVAN, Red Bluff, Cal.
CLEOPHUS SWECKER, Century, W. Va.
PAO-TUNG TONG, Shanghai, China
FRANK ANTON TRACK, Raymond, Wash.
WALTHER JOHN WEFEL, Cleveland, Ohio
WALTER MELVIN WELLS, San Francisco, Cal.
DONALD WITTEN, Kansas City, Mo.
JESSE JOHN WOLTMANN, Washington, D. C.

ELECTED AS ASSOCIATE

ALFRED DAYBILL, New York City

Elected as Juniors

Alejo Aquino y Angeles, Capiz, Philippine Islands
Ingle Barr, Pensacola, Fla.
Leo Francis Brown, Brooklyn, N. Y.
Philip Gilstrap Bruton, Vancouver Barracks, Wash.
Arthur Sackett Butterworth, Waterloo, Iowa
Franklin Harter Craddock, Camp Eustis, Va.
Charles Cunliff, Jr., St. Louis, Mo.
Russell Alger Dodge, Ann Arbor, Mich.
Francis Austin Gerig, Walnut Ridge, Ark.
John Francis Hardecker, Philadelphia, Pa.
George Wilson Malone, Camp Kearney, Cal.
James Bruce O'Brien, Oriente, Cuba
Marshall Woolley Picken, New York City
Thomas Colyer Richardson, Vicksburg, Miss.
William Davis Shipman, Pittsburgh, Pa.
Robert Farquhar Watt, Detroit, Mich.
Norman Kenneth Wilson, London, England

Transferred from Junior to Associate Member

Andrew Lewis Ackhart, Buffalo, N. Y.
Arthur Jerome Barzaghi, Washington, D. C.
Nathaniel Warren Green, Key West, Fla.
Harold Fiske Holley, Carson City, Nev.
Thomas Richard King, Reno, Nev.
Arthur Kraus, Brooklyn, Navy Yard
John Robert O'Donnell, Brooklyn, N. Y.
John Nathaniel Olson, Galveston, Tex.
Leo Francis Reynolds, St. Joseph, Mo.
Carl Edward Sandstedt, Riverside, Cal.
Romney Leigh Vaughn, Oakland, Cal.

Transferred from Associate Member to Member

George Herbert Biles, Harrisburg, Pa.
Delmar Smith Clinton, Washington, D. C.
Arthur Edward Clark, New York City
Vernon Milton Eager, Washington, D. C.
Aymar Embury, 2d, Am. Exp. Forces, France
James Moore Farrin, Chicago, Ill.
Russell Verstille Glenn, Fort Worth, Tex.
Philip Brockett Hill, Little Rock, Ark.
Charles Rea Moore, Valley, Wash.
Gonzalo Claudio Munoz, Washington, D. C.
Henry Lester Newhall, Akron, Ohio

Wallace Cromwell Allen Palmer, Iloilo, P. I.
John Prince Hazen Perry, New York City
Fred Elmer Rightor, Austin, Tex.
Frank Sears Senior, Am. Exp. Forces, France.
William Edward Thomas, Charlotte, N. C.
Martin Wilhelm Torkelson, Madison, Wis.
Constantine Borisson Voynow, Philadelphia, Pa.
Ernst Victor Willard, St. Paul, Minn.

OF THE BOARD OF DIRECTION

(Abstract)

September 10th, 1918.—The Board met at 10.40 P. M., immediately after the adjournment of the Membership Committee; Director Alex. C. Humphreys in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Fay, Noble, and Pegram.

Ballots for membership were canvassed, resulting in the election of 10 Members, 43 Associate Members, 1 Associate, and 17 Juniors and the transfer of 11 Juniors to the grade of Associate Member.

Nineteen Associate Members were transferred to the grade of Member.

A Report from the Membership Committee was received and acted upon.

Adjourned.

ANNOUNCEMENTS

The Reading Room of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

FUTURE MEETINGS

October 2d and 16th, 1918.—8.30 P. M.—Meetings will be held on these evenings as usual, and announcement of the speakers and subjects will be made later.

SEARCHES IN THE LIBRARY

In January, 1902, the Secretary was authorized to make searches in the Library, upon request, and to charge therefor the actual cost to the Society for the extra work required. Since that time many searches have been made, and bibliographies and other information on special subjects furnished.

The resulting satisfaction to the members who have made use of the resources of the Society in this manner has been expressed frequently, and leaves little doubt that if it were generally known to engineers that such assistance could be had, many would avail themselves of it.

On October 1st, 1916, the Library of the American Society of Civil Engineers ceased to exist as such, and was merged in the Engineering Societies Library, adding 67 000 volumes to the collection, which comprises also the former libraries of the American Institute of Mining Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, and now has a total of 133 000 volumes and pamphlets. Containing, as the Library now does, the special collections mentioned, its scope is broadened, and, as it receives an unusually large number of technical periodicals, it is well equipped to continue the service formerly rendered by the Society Library.

The Engineering Societies Library offers this service at a cost which is trifling compared with the value of the time of an engineer who personally looks up such matters, and the work can be performed quite as well, and much more quickly, by persons familiar with the Library.

In asking that such work be undertaken, members should specify clearly the subject to be covered, and whether references to general books only are desired, or whether a complete bibliography, involving search through periodical literature, is desired.

It sometimes happens that references are found which are not readily accessible to the person for whom the search is made. In that case the Library is prepared to furnish photographic copies of the material at a small price per page. This method is particularly useful when there are drawings or figures in the text, which would be very expensive to reproduce by hand.

The Library is also able to provide translations of articles in foreign languages when desired.

Requests for searches, copies, translations, etc., should be addressed to the Director, Engineering Societies Library, 29 West 39th Street, New York City, who will gladly give information concerning the charges for the various kinds of service.

PAPERS AND DISCUSSIONS

Members and others who take part in the oral discussions of the papers presented are urged to revise their remarks promptly. Written communications from those who cannot attend the meetings should be sent in at the earliest possible date after the issue of a paper in *Proceedings.*

All papers accepted by the Publication Committee are classified by the Committee with respect to their availability for discussion at meetings.

Papers which, from their general nature, appear to be of a character suitable for oral discussion will be published as heretofore in *Proceedings,* and set down for presentation to a future meeting of the Society, and, on these, oral discussions, as well as written communications, will be solicited.

All papers which do not come under this heading, that is to say, those which from their mathematical or technical nature, in the opinion of the Committee, are not adapted to oral discussion, will not be scheduled for presentation to any meeting. Such papers will be published in *Proceedings* in the same manner as those which are to be presented at meetings, but written discussions only will be requested for subsequent publication in *Proceedings* and with the paper in the volumes of *Transactions.*

The Board of Direction has adopted rules for the preparation and presentation of papers, which will be found on page 35 of the Year Book for 1918.

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association, Organized 1905.

Jerome Newman, President; Nathan A. Bowers, Secretary-Treasurer, 502 Rialto Building, San Francisco, Cal.

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet, and weekly informal luncheons. The former are held at 6 P. M., at the Palace Hotel, on the third Tuesday of February, April, June, August, October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at noon, every Wednesday, at the Engineers' Club, 57 Post Street, where special tables are reserved for members and guests of the Association.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest.

(Abstract of Minutes of Meeting)

July 23d, 1918.—A special meeting was called to order at the Engineers' Club at 6.40 P. M.; President Newman in the chair; Nathan A. Bowers, Secretary; and present, also, 18 members.

The purpose of the meeting was to consider whether the Association would send a representative to the conference on the revision of the Constitution of the Society, which had been suggested by the Southern California Association, such conference to be held at Salt Lake City, Utah, on August 6th, 1918.

The resolution providing for a Committee on Development of the American Society of Civil Engineers, adopted by the Board of Direction on July 18th, 1918, was summarized and explained by President Newman.

A communication from the Southern California Association was read, in which it was suggested that each of the ten Associations in the four Western Districts send a delegate (who, later, would represent his respective Association at the meeting of the Development Committee), to a conference to be held on August 6th, 1918, at Salt Lake City, Utah. The purpose of such conference was explained as being for a general discussion of the important features of such Development Committee, in order to pool ideas on the subject for all parts of the West, the delegates to report to their respective Associations and thus avoid a duplication of time and effort and make for a broader understanding of what was desired and what would be done by the Committee. The question was discussed by Messrs. Marx, Kibbe, Grunsky, Flinn, White, Vensano, Binkley, Huber, Duryea, Newman, and Bowers.

On motion, duly seconded, it was decided to advise the Southern California Association that the San Francisco Association would send a delegate to the Salt Lake City conference, provided that at least seven of the ten Associations in Districts Nos. 10, 11, and 12, agreed to do likewise.

It was also decided that the name of the delegate should be sent to all members of the Association in order that they might advise him of their ideas on the question.

Adjourned.

Subsequently, by action of the Board of Directors, Mr. H. L. Haehl was selected to represent the Association on the Committee on Development. On August 2d, 1918, only five of the ten Local Associations having signified their intention to send delegates to the Salt Lake City conference, the plan for that meeting was abandoned.

Colorado Association, Organized 1908.

L. R. Hinman, President; A. N. Miller, Secretary-Treasurer, 1122 Detroit Street, Denver, Colo.

The meetings of the Colorado Association of Members of the American Society of Civil Engineers (Denver, Colo.) are held on the second Saturday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary. The meetings are usually preceded by an informal dinner. Members of the American Society of Civil Engineers will be welcomed at these meetings.

Weekly luncheons are held on Wednesday at 12.30 P. M., at Daniels and Fisher's.

Visiting members are urged to attend the meetings and luncheons.

(Abstract of Minutes of Meeting)

June 15th, 1918.—The Tenth Annual Meeting was called to order at the Denver Athletic Club; President Follansbee in the chair; L. R. Hinman, Secretary.

The minutes of the meeting of May 11th, 1918, were read and approved.

President Follansbee read the Annual Address.

The Secretary-Treasurer presented the Annual Reports and the financial statement, and, on motion, duly seconded, these were accepted and ordered filed.

The report of the Nominating Committee was received, and Messrs. Charles W. Comstock and W. L. Drager were appointed Tellers to canvass the ballots for officers.

On the report of the Tellers, the following officers were declared elected: President, L. R. Hinman; Vice-President, E. C. Jansen; and Secretary-Treasurer, A. N. Miller.

The Secretary read the resolutions adopted by the Cleveland Association relative to the appointment of a delegate by each Local Association to constitute a committee to take up the revision of the Constitution of the Society. On motion, duly seconded, the President was authorized to appoint a delegate to attend such meetings as might be called.

Mr. C. A. Fisher, Geologist for the Midwest Refining Company, addressed the meeting on the subject, "Physical Conditions Under Which Oil Occurs and the Various Fields in the United States."

At the conclusion of the address, the President thanked Mr. Fisher on behalf of the Association.

Adjourned.

Atlanta Association, Organized 1912.

B. M. Hall, President; Thomas P. Branch, Secretary-Treasurer, Georgia School of Technology, Atlanta, Ga.

(Abstract of Minutes of Meeting)

July 29th, 1918.—The meeting was called to order at the Chamber of Commerce; President B. M. Hall in the chair; Thomas P. Branch, Secretary; and present, also, 4 members.

The minutes of the meeting of July 5th, 1918, were read and approved.

Thomas P. Branch was elected Secretary for the remainder of this term.

A letter from Secretary Chas. Warren Hunt was read, relative to the appointment of a representative on the Committee on Development of the Society.

On motion, duly seconded, President Hall was given authority to make such appointment, and he named Mr. Arthur Pew. In accepting the appointment, Mr. Pew stated that at one time he was the only member of the Society in Georgia.

On motion, duly seconded, it was decided that members of the Association meet for lunch on the last Monday of each month, at 12.30 P. M.

Adjourned.

Baltimore Association, Organized 1914.

H. G. Perring, President; Charles J. Tilden, Secretary-Treasurer, The Johns Hopkins University, Baltimore, Md.

Cleveland Association, Organized 1914.

Harry Fuller, President; George H. Tinker, Secretary-Treasurer, 516 Columbia Building, Cleveland, Ohio.

Detroit Association, Organized 1916.

T. A. Leisen, President; Clarence W. Hubbell, Secretary, 2348 Penobscot Building, Detroit, Mich.

The regular meetings of the Association are held on the second Friday of December, April, and October, the last being the Annual Meeting.

District of Columbia Association, Organized 1916.

A. P. Davis, President; John C. Hoyt, Secretary-Treasurer, U. S. Geological Survey, Washington, D. C.

Duluth Association, Organized 1917.

W. B. Patton, President; Walter G. Zimmermann, Secretary, Wolvin Building, Duluth, Minn.

The regular meetings of the Association are held at noon on the third Monday of each month (usually at the Kitchi Gammi Club), with luncheon, followed by a short business session and the reading of papers. Visiting members of the American Society of Civil Engineers can secure from the Secretary definite information relating to the meetings, at which they will be welcomed. The Annual Meeting is held on the third Monday in May.

Illinois Association, Organized 1916.

A. S. Baldwin, President; Edgar S. Nethercut, Secretary-Treasurer, 1735 Monadnock Blk., Chicago, Ill.

The regular meetings of the Association are held on the second Monday of March, June, September, and December, the last being the Annual Meeting. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary.

Louisiana Association, Organized 1914.

Arsene Perrilliat, President; Eugene F. Delery, Secretary, 2007 Laharpe St., New Orleans, La.

The regular meetings of the Association are held at The Cabildo, New Orleans, La., on the first Monday of January, April, July, and October.

Nebraska Association, Organized 1917.

George L. Campen, President; Homer V. Knouse, Secretary-Treasurer, 109 City Hall, Omaha, Nebr.

Regular meetings of the Association are held on the first Saturday of each month, except July and August, and at such places as may be appointed from time to time by the Executive Committee. The Annual Meeting is held in Lincoln, Nebr., on the second Friday in January.

An "Engineers' Round Table" is reserved daily for luncheons, at Courtenay's Restaurant, 17th and Douglas Streets, Omaha, to which all engineers are invited. Visiting members of the Society are especially urged to communicate with the Secretary when in the city.

Northwestern Association, Organized 1914.

P. E. Thian, President; Ralph D. Thomas, Secretary, Care St. Anthony Falls Water Power Co. and Minneapolis Mill Co., Minneapolis, Minn.

The meetings of the Association are held bi-monthly, alternating between St. Paul and Minneapolis, on the third Friday of each month. Information as to the time and place of such meetings will be furnished on application to the Secretary.

Philadelphia Association, Organized 1913.

Henry H. Quimby, President; C. W. Thorn, Secretary, Crum Lynne, Pa.

The regular meetings of the Association are held at the Engineers' Club of Philadelphia, 1317 Spruce Street, on the first Monday in January, April, and October, the last being the Annual Meeting.

(Abstract of Minutes of Meeting)

June 18th, 1918.—The meeting was called to order at the Engineers' Club of Philadelphia, at 8.15 P. M.; President Quimby in the chair; C. W. Thorn, Secretary; and present, also, about 250 members and guests.

President Quimby read the resolutions adopted by the Board of Direction of the Association relative to the death of Edgar Marburg, and, on motion, duly seconded, the action of the Board was approved by the meeting.

On motion, duly seconded, the reading of the minutes of the previous meeting was dispensed with.

A paper by Mr. F. P. Heard, entitled "Concrete Ships", was presented by the author, who illustrated his remarks with lantern slides and motion pictures, and the subject was discussed by Messrs. W. A. Slater, R. W. Wig, S. M. Swaab, H. H. Quimby, C. W. Thorn, and others.

Adjourned.

Pittsburgh Association, Organized 1917.

Richard Khuen, Jr., President; John D. Stevenson, Secretary-Treasurer, 1231 Monterey St., Pittsburgh, Pa.

The Annual Meeting of the Association is held on the first Monday in October. The time and place of other meetings are not fixed, but this information will be furnished on application to the Secretary.

Portland, Ore., Association, Organized 1913.

Philip H. Dater, President; C. P. Keyser, Secretary, 318 City Hall, Portland, Ore.

St. Louis Association, Organized 1888 (Constitution Approved by Board, 1914).

J. A. Ockerson, President; C. M. Daily, Secretary-Treasurer, 4240 Shaw Avenue, St. Louis, Mo.

The Annual Meeting of the Association for the election of officers and for the transaction of business, is held on the fourth Monday in November. Two meetings each year, for the presentation and discussion of technical papers, are held in the Auditorium of the Engineers Club of St. Louis and are open to members of the Associated Societies. Other "get-together" meetings are held regularly for dinner or luncheon on the fourth Monday of each month except July, August, and November.

San Diego Association, Organized 1915.

N. B. Kellogg, President; P. R. Watson, Secretary-Treasurer, *pro tem.,* County Engineer's Office, San Diego, Cal.

Seattle Association, Organized 1913.

A. S. Downey, President; Phil. A. Franklin, Secretary, Care, City Engineer's Office, County-City Building, Seattle, Wash.

The regular monthly meetings and luncheons of the Association are held at the Frye Hotel, 3d Avenue and Yesler Way, at 12.15 P. M., on the last Monday of each month. All members, in any grade, of the American Society of Civil Engineers are cordially invited to attend the meetings when in the vicinity.

Southern California Association, Organized 1914.

Louis C. Hill, President; H. W. Dennis, Secretary, Edison Building, Los Angeles, Cal.

The Southern California Association of Members of the American Society of Civil Engineers (Los Angeles, Cal.) holds regular bi-monthly meetings with banquet, at Hotel Clark, on the second Wednesday of February, April, June, August, October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at 12.15 P. M., every Thursday and the place of meeting may be ascertained from the Secretary.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in Los Angeles, and any such member will be gladly welcomed as a guest at any of the meetings or luncheons.

Spokane Association, Organized 1914.

Peter Mogensen, President; Charles E. Davis, Secretary, City Engineer's Office, Spokane, Wash.

The regular meetings of the Association are held on the second Friday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary.

Visiting members are invited to attend the meetings and luncheons.

Texas Association, Organized 1913.

R. C. Gowdy, President; J. H. Brillhart, Secretary, Care, Mosher Mfg. Co., Dallas, Tex.

Utah Association, Organized 1916.

George L. Swendsen, President; H. S. Kleinschmidt, Secretary-Treasurer, 1308 Walker Bank Building, Salt Lake City, Utah.

The Annual Meeting of the Association is held on the first Wednesday in April. The time of other meetings is not fixed, but this information will be furnished on application to the Secretary.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcomed by the following Engineering Societies, both to the use of their Reading Rooms, and at all meetings:

American Institute of Electrical Engineers, 25 West Thirty-ninth Street, New York City.

American Institute of Mining Engineers, 25 West Thirty-ninth Street, New York City.

American Society of Mechanical Engineers, 25 West Thirty-ninth Street, New York City.

Asociación de Ingenieros y Arquitectos de Mexico, Avenida Juarez, 12, City of Mexico, Mexico.

Assoçiacão dos Engenheiros Civis Portuguezes, Lisbon, Portugal.

Australasian Institute of Mining Engineers, Melbourne, Victoria, Australia.

Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass.

Brooklyn Engineers' Club, 117 Remsen Street, Brooklyn, N. Y.

Civil Engineers' Society of St. Paul, Public Library, St. Paul, Minn.

Cleveland Engineering Society, Chamber of Commerce Building, Cleveland, Ohio.

Cleveland Institute of Engineers, Middlesbrough, England.

Dansk Ingeniorforening, Amaliegade 38, Copenhagen, Denmark.

Detroit Engineering Society, Detroit Board of Commerce Building, Detroit, Mich.

Engineering Association of Nashville, Commercial Club Building, Nashville, Tenn.

Engineering Association of New South Wales, 5 Elizabeth Street, Sydney, New South Wales, Australia.

Engineering Institute of Canada, 176 Mansfield Street, Montreal, Que., Canada.

Engineering Societies Club of Hawaii, E. F. Cykler, Secretary, Honolulu, Hawaii.

Engineers and Architects Association of Southern California, 405 Hosfield Bldg., Los Angeles, Cal.

Engineers and Architects Club of Louisville, 1412 Starks Building, Louisville, Ky.

Engineers' Club of Baltimore, 6 West Eager Street, Baltimore, Md.

Engineers' Club of Kansas City, Robert S. Beard, Secretary, Third Floor, City Hall, Kansas City, Mo.

Engineers' Club of Minneapolis, 17 South Sixth Street, Minneapolis, Minn.

Engineers' Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa.

Engineers' Club of St. Louis, 3817 Olive Street, St. Louis, Mo.

Engineers' Club of Toronto, 96 King Street, West, Toronto, Ont., Canada.

Engineers' Club of Trenton, Trent Theatre Building, 12 North Warren Street, Trenton, N. J.

Engineers' Society of Northeastern Pennsylvania, 415 Washington Avenue, Scranton, Pa.

Engineers' Society of Pennsylvania, 31 South Front Street, Harrisburg, Pa.

Engineers' Society of Western Pennsylvania, 568 Union Arcade Building, Pittsburgh, Pa.

Florida Engineering Society, J. R. Benton, Secretary, Gainesville, Fla.

Institute of Marine Engineers, The Minories, Tower Hill, London, E., England.

Institution of Civil Engineers, Great George Street, Westminster, S. W., London, England.

Institution of Engineers of the River Plate, Calle 25 de Mayo 195, Buenos Aires, Argentine Republic.

Institution of Mechanical Engineers, 11 Great George Street, London, S. W. 1, England.

Institution of Naval Architects, 5 Adelphi Terrace, London, W. C., England.

Junior Institution of Engineers, 39 Victoria Street, Westminster, S. W., London, England

Koninklijk Instituut van Ingenieurs, The Hague, The Netherlands.

Louisiana Engineering Society, State Museum Building, Chartres and St. Ann Streets, New Orleans, La.

Memphis Engineers' Club, Memphis, Tenn.

Midland Institute of Mining, Civil and Mechanical Engineers, Sheffield, England.

Montana Society of Engineers, Butte, Mont.

North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, England.

Oregon Society of Civil Engineers, Portland, Ore.

Pacific Northwest Society of Engineers, 803 Central Building, Seattle, Wash.

Rochester Engineering Society, Rochester, N. Y.

Sociedad Colombiana de Ingenieros, Bogota, Colombia.

Sociedad de Ingenieros del Peru, Lima, Peru.

Societe des Ingenieurs Civils de France, 19 rue Blanche, Paris, France.

Society of Engineers, 17 Victoria Street, Westminster, S. W., London, England.

Southwestern Society of Engineers, C. E. Barglebaugh, Secretary, 703 First National Bank Building, El Paso, Tex.

Svenska Teknologforeningen, Brunkebergstorg 18, Stockholm, Sweden.

Tekniske Forening, Vestre Boulevard 18–1, Copenhagen, Denmark.

Vermont Society of Engineers, George A. Reed, Secretary, Montpelier, Vt.

Western Society of Engineers, 1735 Monadnock Block, Chicago, Ill.

ACCESSIONS TO THE ENGINEERING SOCIETIES LIBRARY

(From August 1st to September 1st, 1918)

DONATIONS *

The statements made in these notices are taken from the books themselves, and this Society is not responsible for them.

STORRS:

A Handbook for the Use of Those Interested in the Construction of Short Span Bridges. By John W. and Edward D. Storrs. Concord, N. H., the Authors, 1918. 40 illus., 20 tab., 7 x 4 in., flexible cloth. $1.00.

A small pocketbook containing designs and methods of construction of small highway bridges, culverts, etc. Intended to assist men without engineering training in the construction of such structures.

ELECTRICAL PHENOMENA IN PARALLEL CONDUCTORS;

Vol. I, Elements of Transmission. By Frederick Eugene Pernot. N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1918. 12 + 332 pp., 82 illus., 35 tab., 9 x 6 in., cloth. $4.00.

Gives the mathematical developments leading to solutions for a number of problems arising in connection with the transmission of electrical energy over metallic circuits. Deals with continuously alternating-current phenomena only, and is intended to serve as an introduction to subsequent volumes dealing with specialized forms of electrical transmission. There is an appendix containing formulas and tables. Contents: Phenomena in Continuous-Current Transmission over Non-Leaky Lines; Direct-Current Line with Leakage; Periodic and Alternating Quantities; Fourier's Series and Analysis of Periodic Curves; Treatment of Non-Sinusoidal Alternating Quantities; The Use of the Oscillograph; Equations of Motion of the Galvanometer Mirror in the Electromagnetic Type of Oscillograph; Alternating-Current Phenomena in an Ideal Line; The Propogation Constant; The Equivalent Impedance of Circuits and the Determination of the Fundamental Constants by Measurement; Change of Wave Shape Along Lines; Power Relations in Long Lines; Voltage Regulation.

THE DESIGN OF AEROPLANES.

By Arthur W. Judge. Lond. & N. Y., Whittaker & Co., 1917. 10 + 242 pp., 90 illus., 67 tab., 9 x 6 in., cloth. $4.00. (Gift of Macmillan Co.).

This volume endeavors to fulfill the need for a compendium in which the principles underlying airplane design, from the standpoint of the mechanical engineer, are concisely presented and accompanied by the necessary data. A small amount of new matter has been inserted in this edition, typographical errors have been corrected, and a chapter on fuselage design and construction has been added. Contains a bibliography.

AEROPLANE CONSTRUCTION AND OPERATION:

Including Notes on Aeroplane Design and Aerodynamic Calculation, Materials, Etc.: A Comprehensive Illustrated Manual of Instruction for Aeroplane Constructors, Aviators, Aero-Mechanics, Flight Officers, and Students; Adapted Either for Schools or Home Study. By John B. Rathbun. Chic., Stanton and Van Vliet Co., 1918. 426 pp., illus., pl., charts, diag., tab., 8 x 5 in., cloth. $2.00.

The author has attempted to produce a book between the popular descriptive work and the mathematical engineering treatise, which will meet the needs of aviators and airplane builders. The volume covers the subject concisely and simply with the use of only elementary mathematics.

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* Unless otherwise specified, books in this list have been donated by the publishers.

CHEMICAL CONTROL OF GAS MANUFACTURE:

Practical Instruction in Gas Works Chemistry for Superintendents, Foremen, and Chemists; Part I, Practical Application. By W. M. Russell. Part II, Elementary Chemical Theory. By F. Wills. N. Y., The Gas Age, 1916. 152 pp., 47 illus., 1 pl., 18 tab., 8 x 5 in., cloth. $1.50.

Devoted to a discussion of the methods for controlling gas-works processes by the use of chemistry, giving the most recent and reliable tests and analyses and explaining the methods used. Adapted to the requirements of men in the smaller plants.

A HANDBOOK OF BRIQUETTING.

By G. Franke. Translated by Fred C. A. H. Lantsberry. Vol. II, Briquetting of Ores, Metallurgical Products, Metal Swarf, and Similar Materials, Including Agglomeration. Lond., Charles Griffin & Co., Ltd.; Phila., J. B. Lippincott Co., 1918. 11 + 214 pp., 79 illus., 4 folded pl., 14 tab., 9 x 6 in., cloth. (Gift of J. B. Lippincott Co.)

Describes the various materials briquetted, methods of briquetting and agglomeration, preparation of material, compression and subsequent treatment of briquettes. A number of complete briquetting and agglomeration plants in Germany and Austria are shown in detail. Appendices to Volumes 1 and 2 are included.

STEAM ENGINES:

A Thorough and Practical Presentation of Modern Steam Engine Practice. By Llewellyn V. Ludy. Chic., American Technical Society, 1917. 192 pp., 103 illus., 1 pl., 8 tab., 8 x 6 in. $1.00.

Treats of the theory and construction of various types of steam engines and of their purchase, operation, and testing. A non-mathematical treatise intended for stationary engineers and particularly adapted for home study.

HOW WOODEN SHIPS ARE BUILT.

A Practical Treatise on Modern American Wooden Ship Construction with a Supplement on Laying Off Wooden Vessels. By H. Cole Estep. Cleveland, The Penton Pub. Co., 1918. 11 + 101 pp., 201 illus., 6 tab., 12 x 9 in., cloth.

This book is a revised publication of a series of articles which appeared in *The Marine Review.* It deals with methods of construction rather than with ship design, and is intended for shipbuilders rather than for naval architects. A supplement on methods of laying down wooden ships is included.

HYDRAULIC AND PLACER MINING.

By Eugene B. Wilson. 3d ed., thoroughly revised. N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1918. 425 pp., 95 illus., 1 pl., 20 tab., 8 x 5 in., cloth. $3.00.

This edition contains much additional information intended to bring the work abreast of the latest improvements in this industry. The book is designed to appeal not only to those actually engaged in placer mining, but also to those who want the latest ideas on the subject.

ALLEN'S COMMERCIAL ORGANIC ANALYSIS:

A Treatise on the Properties, Modes of Assaying, and Proximate Analytical Examination of the Various Organic Chemicals and Products Employed in the Arts, Manufactures, Medicines, Etc., with Concise Methods for the Detection and Estimation of Their Impurities, Adulterations, and Products of Decomposition; Vol. IV. Edited by

W. A. Davis and Samuel S. Sadtler and the Following Contributors: M. Bennett Blackler, E. W. Lewis, T. Martin Lowry, Ernst J. Parry, Henry Leffmann, Charles H. Lawall. 4th ed., entirely rewritten. Phila., P. Blakiston's Son & Co. (copyright 1911, reprinted 1917). 466 pp., tab., 9 x 6 in., cloth. $5.00.

The subject has been divided between a number of authorities, and much new matter has been included, so that the volume forms a convenient compendium of present knowledge on the subject.

STANDARD COTTON MILL PRACTICE AND EQUIPMENT;

With Classified Buyers' Index. Boston, The National Association of Cotton Manufacturers, 1918. 203 pp., illus., tab., 9 x 6 in., cloth. $1.50.

An annual encyclopedia, containing economic trade and engineering data of interest to mill executives. Contains also a classified directory of manufacturers of cotton mill supplies and equipment.

UNIFORM COST ACCOUNTING FOR STEEL FURNITURE INDUSTRY.

Compiled by Erich W. Kath. [Cleveland], The National Association of Steel Furniture Manufacturers (copyright, 1918). 106 pp., 5 forms, 8 x 5 in., cloth.

The methods of ascertaining costs presented are the result of careful investigation of the conditions in different organizations. The systems recommended are in accord with the best practices of accounting and, with minor changes, can be adapted to the needs of the various concerns.

HANDBOOK OF MATHEMATICS FOR ENGINEERS.

By Edward V. Huntington. With Tables of Weights and Measures by Louis A. Fischer. N. Y., McGraw-Hill Book Co., Inc.; London, Hill Pub. Co., Ltd., 1918. 191 pp., illus., tab., 7 x 5 in., flexible cloth. $1.50.

Designed to supply, in compact form, accurate statements of those facts and formulas of pure mathematics, which are most likely to be of use to the worker in applied mathematics. Reprinted from Marks' "Mechanical Engineers' Handbook."

ELECTRIC LOCKING.

By James Anderson. N. Y., Simmons-Boardman Publishing Co. (copyright, 1918). 210 illus., 9 x 6 in. $2.00.

Describes in detail the various methods for the supplementary protection of a system of interlocking switches, the apparatus used, methods of wiring, etc. Portions of the book appeared in the *Railway Signal Engineer*.

MUNICIPAL HOUSECLEANING:

The Methods and Experiences of American Cities in Collecting and Disposing of Their Municipal Wastes—Ashes, Rubbish, Garbage, Manure, Sewage, and Street Refuse. By William Parr Capes and Jeanne Daniels Carpenter, with an Introduction by Cornelius F. Burns. N. Y., E. P. Dutton & Co., 1918. 20 + 232 pp., 16 tab. (2 folded) 10 x 6 in., cloth. $6.00.

Designed to furnish the information needed by those who are interested in the problems of the collection, and care and disposal of municipal wastes. The authors also take up the need for more efficient management and for the development of revenue-producing by-products. Intended to help public officials in selecting and operating the system best adapted to local conditions, and also to serve as a guide to the layman who wishes to inform himself about the methods of municipal housecleaning.

WATER RIGHTS DETERMINATION:

From an Engineering Standpoint. By Jay M. Whitham. N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1918. 12 + 204 pp., tab., 9 x 6 in., cloth. $2.50.

Intended to assist an owner of an indefinite water right in determining the meaning of his right as expressed in horse-powers, and the number of cubic feet of water per second to which he is entitled. Gives citations from representative writings and presents many tests and power determinations used by the author. A bibliography is included.

PORTS AND TERMINAL FACILITIES.

By Roy S. MacElwee. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Pub. Co., Ltd., 1918. 315 pp., 118 illus., 1 folded map, 17 tab., 9 x 6 in., cloth. $3.00.

This is a revision of the material used in a course of lectures at the School of Business, Columbia University. Discusses some of the engineering and economic factors which determine the success or failure of a port. Contents: The Nature of the Problem; The Relative Importance and Physical Characteristics of the World's Leading Ports; General Characteristics of a Well-Co-ordinated Seaport; Port Competition for Rail and Maritime Freight; The Harbor Belt Railway and Competition at the Terminals; Lighterage, Cartage, Drays and Motor Trucks; Piers, Wharves and Quays; Wharf Equipment; Cargo Transfer and Handling; Shed Equipment; The Warehouse; Standard Package or Specialized Freight; Bulk Freight; Inland Waterways and the Seaport; The Industrial Harbor and Upland Development; The Free Port as an Institution; The Processes by Which the Free Ports of Hamburg and Bremen were Created; Bibliography.

ROLL OF HONOR

A List of Members of the Society Who are Serving in the Army or Navy of the United States or Any of Its Allies.*

VANSITTART, GEORGE EDWARD. *Maj., 13th Battery, Canadian Field Artillery, 2d Canadian Div.; wounded in action (France); died May 14th, 1916.*

AGNEW, AUGUSTUS WATEROUS. *Capt., 3d Canadian Pioneers; wounded in action (France); died September 17th, 1916.*

HAGUE, WILLIAM. *1st Lieut., Engr. R. C., 116th Engrs.; died in service (France), January 1st, 1918.*

GOODFELLOW, JAMES GORDON. *Maj., Royal Engrs.; killed in action (France), March 23d, 1918.*

BUCKWALTER, DANIEL HARRIS. *Capt., Engr. R. C.; killed in action (France), May 12th, 1918.*

LINDBERY, CHARLES ARTHUR. *Capt., Engr. R. C.; died in service (Camp Lee, Va.).*

Abbot, Frederic V. Brig.-Gen., Corps of Engrs., N. A.

Abbot, Frederick William. Lt.-Col., British Army.

Acher, A. H. Maj., Corps of Engrs., U. S. A.; Acting Lt.-Col., 4th Engrs., A. E. F., France.

Acker, Robert L. Corporal, Headquarters Co., 7th Field Artillery, A. E. F., France.

Ackerman, Alexander S. Capt., Engr. R. C., A. E. F., France.

Ackerman, Arthur P. 1st Lieut., Engr. R. C., 517th Engrs.

Adams, Arthur. Maj., Ord. R. C.

Adams, Edward M. Maj., U. S. A.

Adams, Milton Jewell. Capt., Engr. R. C., Co. C, 114th Engrs.

Adams, Raymond E. Capt., Q. M. R. C.

Adams, Walter Francis. Sergeant, 23d Engrs., A. E. F., France.

Adams, William H. Capt., Q. M. C., U. S. A.

Albert, Frederick W. Lt.-Col., Engrs., N. A., 33d Engrs.

Alden, Herbert C. 1st Lieut., C. A., U. S. A.

Alden, Langford Taylor. Aspirant, 7^{e} Batterie, 51st Regt. d'Artillerie, Secteur Postal No. 82 (French Army); Care, Morgan, Harjes Cie., Boulevard Haussmann, Paris, France.

Alexander, E. Porter. 1st Lieut., Engr. R. C., 509th Engrs., A. P. O. 701, A. E. F., France.

Alexander, Kay. Maj., 2d in Command, 12th Canadian Ry. Troops, B. E. F., France.

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* This list is made up from replies to a circular forwarded to members of the Society, and others, and is probably neither accurate nor complete. It is requested that the attention of the Secretary be called to any omissions or inaccuracies in order that they may be corrected in subsequent lists.

Allen, Franklin R. Capt., Engr. R. C.

Allen, Herschel Heathcote. Capt., Engr. R. C.

Allen, Ralph B. 1st Lieut., Engr. R. C., Co. B, 25th Engrs., A. E. F., France.

Allen, Walter Henry. Maj., Engr. R. C.

Allen, Walter Hinds. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Allison, William F. Maj., Engr. R. C., A. E. F., France.

Altman, Frank S. Lieut., Engr. R. C., 23d Engrs.

Altstaetter, F. W. Col., Corps of Engrs., U. S. A.

Anderson, J. E. Maj., 212th Field Co., Royal Engrs., B. E. F., France.

Anderson, J. H. Capt., Engr. R. C.; Adjt., 1st Replacement Engrs.

Anderson, W. P. Capt., Engr. R. C., A. E. F., France.

Anderson, W. S. Cadet, School of Military Aeronautics.

Andrew, Clarence R. Capt., Engr. R. C., 32d Engrs.

Andrews, Carl B. Capt., Engr. R. C.

Andrews, J. H. M. Maj., Ord. R. C.

Angas, Robert M. 1st Lieut., U. S. N. G., 106th Engrs.

Annear, E. H. Capt., Engr. R. C., 20th Engrs.

Applegarth, Gault. Capt., Engr. R. C., 23d Engrs.

Ardery, Edward Dahl. Col., Corps of Engrs., U. S. A.; Chf. Gas Officer, 2d Army Corps, A. E. F., France.

Armitage, George W. Capt., Q. M. R. C.

Arms, Leo M. Lieut., Engr. R. C., Co. F, 2d Engrs., A. E. F., France.

Armstrong, Charles Johnstone. Brig.-Gen.; Chf. Engr., H. Q., Canadian Army Corps, B. E. F., France.

Armstrong, Merwin. Capt., Engr. R. C., Co. B, 105th Engrs.

Arn, William G. Maj., Engrs., N. A., 13th U. S. Engrs. (Ry.), Postal Sector 215, A. E. F., France.

Ashkins, Nathan Thomas. 1st Lieut., Engr. R. C., Lines of Communication, Eng. Headquarters, A. E. F., France.

Ashley, Carl. Capt., Engr. R. C., U. S. Military P. O. 702, A. E. F., France.

Ashmead, P. H. Maj., Engr. R. C.

Ashton, Raymond. 2d Lieut., A. S., Sig. R. C., A. E. F., France.

Asplundh, E. T. Capt., Engr. R. C.; Supply Officer, 103d Engrs.

Asserson, Henry Raymond. Maj., Engr. R. C., C. E. L. O. C., A. E. F., France.

Atterbury, W. W. Brig.-Gen.; Director-General of Transportation, A. E. F., France.

Atwood, William G. Lt.-Col., Engrs., N. A., 17th Engrs. (Ry.), U. S. A. P. O. 701, A. E. F., St. Nazaire, France.

Austill, Hurieosco. Capt., Engr. R. C., Co. D, 501st Engrs. (Service Bn.), A. E. F., France.

Austin, H. A. R. 1st Lieut., Engrs., U. S. A.

Ayres, John Henry. Capt., Engr. R. C., Co. D, 42d Engrs.

Ayres, Quincy C. 2d Lieut., Engr. R. C. (*Unattached*), A. E. F., France.

Babbitt, Harold E. Capt., Engr. R. C., Chf. Engr.'s Office, Adv. Sect. S. O. S., U. S. P. O. No. 714, A. E. F., France.

Baffrey, Charles R. Capt., 102d Reg. d'Artillerie (French Army), Secteur Postal 160, B. C. M., Paris, France.

Bailey, Lewis P. Capt., Engr. R. C., Co. A, 304th Engrs.

Bakenhus, R. E. Civ. Engr., U. S. N. (rank of Commander).

Baker, George L. 1st Lieut., Inf., N. A.

Baker, H. S. Lt.-Col., Engrs., N. A., 111th Engrs.

Baker, Shirley. Capt., Engr. R. C., Co. B, 23d Engrs.

Balch, William H. Capt., Engr. R. C., A. P. O. 712, A. E. F., France.

Barber, Charles W. Private, 38th U. S. Engrs.

Barber, Justin F. Sergeant, Co. M, 23d Engrs., A. E. F., France.

Barber, Norman N. Capt., Engrs., N. A., 16th Engrs., A. E. F., France.

Barclay, A. J. 1st Lieut., Engr. R. C.

Barney, Samuel E. Maj., Engr. R. C. (*Unassigned*).

Bartholomew, B. W. Lieut., Engr. R. C., 301st Engrs.

Bascom, George R. Maj., San. C., N. A.

Bassett, Herbert H. Maj., Engr. R. C.

Battie, H. S. 1st Lieut., Engr. R. C.

Baxter, O. G. Capt., Engr. R. C., Co. C, 601st Engrs.

Bayliss, Paul. 2d Lieut., Engr. R. C., 8th Engrs. (Mounted).

Beach, Lansing H. Col., Corps of Engrs., U. S. A.

Beall, Pendleton. Private, Headquarters Co., 165th Inf., A. E. F., France.

Beam, Carl Eugene. 2d Lieut., Engrs., N. A.

Bebb, Edward C. Capt., Engr. R. C.

Beeman, Thomas R. Capt., Engr. R. C., Care, D. G. T., A. E. F., France.

Beerbower, Dumont. Capt., Engrs., N. A., Co. C, 535th Engrs.

Begg, R. B. H. Capt., Engr. R. C., A. E. F., France.

Behrman, I. E. 1st Lieut., Engr. R. C., Care, C. E. O., Zone of the Advance, A. E. F., France.

Belknap, Francis W. U. S. Army P. O. 705, A. E. F., France.

Bell, George Edward. Lieut., Canadian Engrs., Care, Bank of Montreal, Waterloo Pl., London, S. W., 1, England.

Bell, Harry W. Capt., Engr. R. C.

Bellinger, L. F. Civ. Engr., U. S. N. (rank of Commander).

Benham, Claude Gilbert. Capt., C. A. C., U. S. A.

Benham, W. L. Maj., Q. M. R. C.

Bennett, John W. F. Maj., Q. M. C., N. A.

Bennison, Ernest William. 1st Lieut., Engr. R. C., 23d Engrs.

Bensel, J. A. Maj., Engr. R. C.

Benson, Orville. Maj., Engr. R. C., A. E. F., France.

Berdeau, Ray W. Capt., Engr. R. C.

Bergan, Thomas B. Lieut., N. A.

Betts, Clifford A. 1st Lieut., C. A. R. C., Battery E, 52d Artillery, A. E. F., France.

Biddle, John. Maj.-Gen., U. S. A.

Billings, A. W. K. Lt.-Commander, Care, Commander, U. S. Naval Aviation Forces, Paris, France.

Billings, Fred M. Capt., Engr. R. C.

Binckley, George Sydney. Maj., Engr. R. C., 112th Engrs.

Binger, Walter D. 2d Lieut., Sig. R. C.

Birdseye, Claude H. Maj., Engrs., U. S. A., Office, Chf. of Artillery, A. P. O. 706, A. E. F., France.

Bishop, Roy P. 2d Lieut., Engr. R. C., 35th Engrs., A. P. O. 735, A. E. F., France.

Bither, T. A. 2d Lieut., Sig. R. C., A. S.

Bixby, William H. Brig.-Gen., U. S. A. (*Retired*).

Black, Dudley F. Capt., Engr. R. C., Co. C, 513th Engrs., A. E. F., France.

Black, G. G. Capt., Engr. R. C.; Acting Adjt., 314th Engrs.

Black, James B. 1st Lieut., Engr. R. C., Chf. Engr.'s Office, Headquarters, A. E. F., France.

Black, Ralph P. 1st Lieut., Engr. R. C., 32d Engrs.

Black, Roger Derby. Lt.-Col., Corps of Engrs., U. S. A., Headquarters, A. E. F., France.

Black, William M. Maj.-Gen.; Chf. of Engrs., U. S. A.

Blackman, J. W. B. Lieut., Canadian Ry. Troops, C. E. F., France.

Blair, Alexander. 2d Lieut., Royal Engrs., B. E. F., France.

Blair, McCrea Parker. Capt., No. 1 Depot Bn., Manitoba Regt., Winnipeg, Man., Canada.

Blanchard, Murray. Maj., Engr. R. C., 520th Engrs.

Boesch, Clarence E. Capt., U. S. N. G., Co. B, 105th Engrs.

Boggs, F. C. Col., 315th Engrs., N. A.

Boland, Charles J. 1st Lieut., Sig. C., U. S. A., 80th Aero Squadron, A. E. F., France.

Bolin, Harry W. Sergeant, Co. E, 23d Engrs.

Bolton, Frank L. Capt., Engr. R. C., 20th Engrs.

Bond, P. S. Col., 107th Engrs., N. A.; Div. Engr., 32d Div., Army Engr. School, U. S. P. O. 714, A. E. F., France.

Bonner, John P. Capt., C. A. R. C., A. E. F., France.

Boorman, Kitchell M. Lieut., Sig. C., U. S. A., 481st Aero Squadron, A. E. F., France.

Booth, Raymond. 1st Lieut., Engr. R. C., 54th Engrs.

Booz, Horace Corey. Col., R. T. C., N. A., Care, D. G. T., A. E. F., France.

Borden, Guy. Co. 2, E. O. T. C., Camp Humphreys, Va.

Bosche, Guy. Capt., Engr. R. C., M. P. O. 705, A. E. F., France.

Bott, C. N. 1st Lieut., Engr. R. C., 312th Engrs.

Bowen, Edward Withers. Capt., Inf. R. C., 2d Inf. Replacement Regt.

Bowlby, Henry L. Maj., 43d Engrs., N. A.

Bowles, James T.-B. Maj., San. C., N. A.

Bowne, Sidney B. 2d Lieut., U. S. Public Health Service.

Boyd, George R. Capt., Engr. R. C., A. E. F., France.

Boyden, Harry C. Maj., Engrs., U. S. A.

Boyle, James M. Maj., Ord. R. C.

Bragg, Kendal B. Asst. Civ. Engr. (rank of Lieut. (Junior Grade)).

Braly, Raymond F. 1st Lieut., Engr. R. C.

Braunworth, Percy L. Capt., Engr. R. C., Care, Director General of Transportation, Army P. O. 705, A. E. F., France.

Bres, Edward Sedley. 1st Lieut., Engr. R. C., 114th Engrs.

Brewster, Henry B. Capt., Engr. R. C., and Adjt., 303d Engrs.

Breymann, John B., Jr. 2d Lieut., C. A. R. C., 22d Co.

Briggs, Robert W. 2d Lieut., Sig. R. C., A. S., 73d Aero Constr. Squadron.

Bright, Graham B. Capt., Engr. R. C., and Regimental Adjt., 305th Engrs. (Pioneers).

Brinkley, Milo H. Capt., Engr. R. C.

Bronson, Howard F. Capt., San. C., N. A.

Brook, A. E. Capt., Royal Engrs., B. E. F., France.

Brooking, J. H. Capt., Engr. R. C., Co. B, 12th Engrs. (Ry.), A. E. F., France.

Brooks, Josiah R. 1st Lieut., Engr. R. C.

Brown, Charles E. Capt., Engr. R. C.

Brown, Clarence C. 1st Lieut., Co. E, 12th Engrs. (Ry.), A. E. F., France.

Brown, Earl I. Col., 317th Engrs.

Brown, Elbert C. Capt., Engrs., U. S. R.

Brown, Elliot C. Lt.-Commander, U. S. N. R.

Brown, H. Whittemore. 2d Lieut., Engr. R. C., A. E. F., France.

Brown, Harry Madara. 1st Lieut., Inf. R. C. (*Unassigned*).

Brown, Levant R. Capt., Engr. R. C.

Brown, Marshall W. Maj., Engr. R. C., P. O. 702, A. E. F., France.

Brown, Norman F. Maj., R. T. C., N. A., Care, Director-Gen. of Transportation, A. E. F., France.

Brown, Robert H. Capt., San. C., N. A.

Brownell, E. H. Civ. Engr., U. S. N. (rank of Commander).

Bruner, Louis S. 1st Lieut., Engrs., U. S. A., 23d Engrs., A. E. F., France.

Brush, Carl F. Capt., Engr. R. C., A. P. O. 716, A. E. F., France.

Bryan, Clark A. Capt., Engr. R. C.

Buchanan, Warren Henderson. Chf. Machinist Mate, U. S. N. R. F.

Bucher, Harold F. Lieut., Engr. R. C., 2d Engrs., A. E. F., France.

Buck, Richard S. Maj., 11th Engrs. (Ry.), A. E. F., France.

Buck, Walter Van. Capt., Engr. R. C., 23d Engrs.

Bunker, George H. Capt., Engr. R. C., 306th Engrs.

Bunker, Stephen S. Capt., Engr. R. C., Co. C, 503d Service Bn., A. E. F., France.

Burd, Edward M. Capt., C. A. R. C.

Burdett, O. L. Capt., Engr. R. C., Co. A, 25th Engrs., A. E. F., France.

Burger, Alfred A. 2d Lieut., Inf. N. A., 19th Co., 2d Inf. Replacement Regt.

Burgess, Harry. Col., N. A., 16th Engrs. (Ry.), A. E. F., France.

Burkett, Joseph M. Capt., Engr. R. C., A. E. F., France.

Burky, C. R. Capt., Sig. R. C., A. S.

Burr, Edward. Col., Corps of Engrs., U. S. A., Manila, Philippine Islands.

Burrell, Glenn S. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Burrowes, H. G. 1st Lieut., Engr. R. C., Co. B, 25th Engrs., A. E. F., France.

Burt, Henry J. Maj., Q. M. C., N. A.

Burton, William. 1st Lieut., Engr. R. C.

Bush, Lee M. Central Officers' Training School, Camp Zachary Taylor, Ky.

Bush, Lincoln. Col., Q. M. C., U. S. A.

Bushnell, Howard B. Capt., Engr. R. C., A. E. F., France.

Bushnell, Howard E. Capt., Engr. R. C.

Busse, Franz A. Capt., Engr. R. C. (*Unattached*), A. E. F., France.

Butler, John Soule. Maj., Engr. R. C.

Butler, Millard A. Col., Q. M. C., N. A.

Butler, William P. Lieut., U. S. N. R. F.

Byam, L. H. Capt., Engr. R. C.

Byllesby, Henry M. Maj., Sig. R. C., A. S.

Byrd, J. H. Capt., Engr. R. C., 314th Engrs.

Caffall, Geoffrey A. Private, No. 1 Coy., Canadian Machine Gun Depot, Seaford, Sussex, England.

Caldwell, William H. Lieut., U. S. N. R. F.

Cameron, Harry Frank. Lt.-Col., 4th Engr. Training Regt., Camp A. A. Humphreys, Va.

Camp, George Dashiell. 1st Lieut., Engr. R. C., 316th Engrs.

Campbell, Charles C. Private, Co. No. 13, Motor Group, Med. C.

Canfield, George Hathaway. Capt., Engr. R. C., 316th Engrs.

Carey, Matthew L. Capt., Q. M. R. C., A. E. F., France.

Carey, William N. Maj., 1st Bn., 313th Engrs.

Carlin, J. P. Capt., Engr. R. C.

Carlson, Carl Alexius. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Caro, Phillip. Lieut., 2d Junior Co., No. 4 Command Depot, A. T. F., Codford, Wiltshire, England.

Carroll, James E. Maj., Engr. R. C., 527th Engrs., A. P. O. 701, A. E. F., France.

Carter, E. Kemper. Capt., Engr. R. C., Co. C, 518th Engrs.

Case, Charles A. 1st Lieut., Engr. R. C., 314th Engrs.

Cate, Charles Edward. Capt., 45th Engrs., N. A.

Caton, John H., 3d. Capt., Engr. R. C., Co. F, 33d Engrs.

Cattell, William A. Maj., Engr. R. C.

Cerny, John W. Maj., Q. M. C., N. A.

Chadwick, Maurice F. Private, 24th Tr. Bn., F. A. R. D., Camp Jackson, S. C.

Chamberlaine, Robert L. Capt., A. S., Sig. R. C.

Chambers, Frank T. Civ. Engr., U. S. N. (rank of Captain).

Chandler, William E. Master Gunner, Headquarters Co., 55th Artillery, C. A. C., A. P. O. 723, A. E. F., France.

Chapman, Mellville D. Lieut., U. S. Marine Corps.

Charnley, Walter. 1st Lieut., Engrs., U. S. A.

Chase, Clifford E. Capt., Engr. R. C., Co. A, 4th Engrs.

Cheney, Sherwood A. Col., N. A., 110th Engrs., A. E. F., France.

Cherry, Alan Gordon. 1st Lieut., N. A., 301st Engrs.

Chevalier, Willard T. Capt., Engr. R. C., Co. D, 11th Engrs. (Ry.), A. E. F., France.

Child, John T. 2d Lieut., San. C., N. A.

Chittenden, Albert Frederick. 1st Lieut., Engr. R. C., Co. F, 18th Engrs. (Ry.), P. O. No. 705, A. E. F., France.

Christensen, George A. Capt., Q. M. R. C.

Christophers, Reginald Gillon. (No. 60286), 2d Lieut., 34th Reinforcements, N. Z. E. F.

Church, Elihu C. Capt., Engr. R. C., A. E. F., France.

Churchill, Percival M. Maj., Engr. R. C., Headquarters, 538th Engrs.

Churchill, Robert C. Lieut., Co. D, 25th Engrs., A. E. F., France.

Claflin, William B. Capt., Engr. R. C., Headquarters, 39th Div.

Claiborne, Herbert A., Jr. 2d Lieut., Sig. R. C. (*Unassigned*).

Clark, Ernest A. Capt., Engr. R. C.

Clark, Howard F. Capt., Engr. R. C., A. E. F., France.

Clarke, Harry L. 1st Lieut., Engr. R. C., Co. E, 28th Engrs., N. A.

Clarke, Thomas C. Lt.-Col., 110th Engrs., A. E. F., France.

Clarke, W. D. Capt., Engr. R. C., 23d Engrs. (Highway), A. E. F., France.

Clayton, Thomas W. Capt., Engr. R. C., A. E. F., France.

Cleckner, Frederick M. Private, Meteorological Section, Sig. C.

Cleveland, Lou B. 1st Lieut., Engr. R. C., Co. D, 105th Engrs.

Clinton, Delmar S. Maj., Engr. R. C.

Cobb, William R. Lieut., U. S. N. N. V., U. S. S. *Frederick.*

Cochrane, Victor Hugo. Maj., Q. M. C., N. A.

Coe, C. S. Maj., Engrs., N. A., 17th Engrs. (Ry.), A. P. O. 701, A. E. F., France.

Coe, David. Capt., R. E., Care, R. C. E., Communications, A. P. O., S 1, B. E. F., France.

Coe, E. K. Maj., Engr. R. C., Care, C. E. O., L. of C., U. S. M. P. O. No. 702, A. E. F., France.

Cole, Howard J. Capt., Engr. R. C.

Coleman, Eugene H. Capt., Engr. R. C., 312th Engrs.

Colgan, R. J. Capt., 11th Engrs. (Ry.), A. E. F., France.

Collins, Earl H. Capt., C. A. R. C.

Collins, Merton C. 1st Lieut., Engr. R. C.

Columbia, Curtis F. 1st Lieut., C. A. R. C., Heavy Artillery Headquarters, A. E. F., France.

Comly, Harry S. Meteorologist, Sig. C, 32d Service Co., Meteorological Section, U. S. A.

Comly, James R. 1st Lieut., Engr. R. C., 55th Engrs.

Compton, Arthur M. Lt.-Col., 126th F. A.

Compton, R. Keith. Maj., Engr. R. C.

Conard, Clarence Knight. Maj., Ord. R. C.

Conard, R. A. Civ. Engr., U. S. N. R. F., Port au Prince, Haiti.

Connelly, Walter L. Master Engr., Senior Grade, Headquarters Detachment, 310th Engrs.

Connolly, A. H. Cadet, School of Military Aeronautics.

Connor, W. D. Col., N. A., Gen. Staff; Asst. Chf. of Staff, A. E. F., France.

Converse, Joseph B. Lieut., U. S. A., Constr. Div.

Conway, N. B. Capt., Engr. R. C., 516th Engrs.

Cook, Paul D. Capt., Engr. R. C., 109th Engrs.

Cooke, Frederick H. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Cooksey, R. M. Maj., Q. M. C., U. S. A.

Coombs, Robert D. Maj., Ord. R. C.

Coomer, R. M. Capt., Engr. R. C., Headquarters, Eng. Corps, Line of Communications, A. E. F., France.

Cooper, David R. Capt., Engr. R. C., A. E. F., France.

Cooper, Hugh L. Lt.-Col., N. A., A. E. F., France.

Copeland, Robert Morris. 2d Lieut., Engr. R. C.; Instr., 111th Engrs.

Corkran, Wilbur Sherman. Capt., Engrs., U. S. A., Co. A, 1st Engrs., A. E. F., France.

Cornell, J. W. Capt., Q. M. C., N. A.

Cornish, Lorenzo D. Capt., Engr. R. C., Co. C, 15th Engrs. (Ry.), A. E. F., France.

Cosby, Spencer. Col., Corps of Engrs., U. S. A., 5th Engrs.

Cotter, Carl Henry. Asst. Civ. Engr., U. S. N.

Covert, John F. 1st Lieut., Engr. R. C.

Cowles, William Pierce. Maj., Engr. R. C., 34th Engrs., A. E. F., France.

Cox, Leonard M. Civ. Engr., U. S. N. (rank of Commander).

Coy, Burgis G. Capt., Engrs., U. S. A., Co. D, 314th Engrs., A. E. F., France.

Cragin, Charles Calhoun. Capt., Co. C, 18th Engrs. (Ry.), A. E. F., France.

Crandall, Carl. Flying Cadet, U. S. Air Service.

Crane, Albert Eli. 1st Lieut., Engr. R. C., 6th Engrs., A. E. F.. France.

Crane, Joseph S. Maj., Q. M. C., N. A.

Crawford, Hugh W. Capt., Co. A, 110th Engrs.

Crawford, Ivan C. Maj., U. S. N. G., 115th Engrs.

Crecelius, S. F. Lt.-Col., Engr. R. C., 101st Engrs., A. E. F., France.

Crocker, Herbert Samuel. Maj., Engr. R. C.

Crocker, James R. Capt., Engr. R. C., Co. F, 106th Engrs.

Crooks, Clinton H. Capt., Engrs., U. S. A.

Crosby, W. W. Lt.-Col., Engrs., N. A.

Crowell, Francis S. Capt., Q. M. C., N. A.

Crozier, William. Maj.-Gen., U. S. A.; Chief of Ordnance, U. S. A.

Cudebec, Albert B. Capt., Engr. R. C., U. S. Military P. O. No. 702, A. E. F., France.

Culver, Arthur. Lieut., R. E., 156th Field Co., R. E., B. E. F., France.

Cunningham, John G. L. Capt., Ord. R. C.

Curfman, Lawrence E. Maj., Engr. R. C., 314th Engrs.

Currey, J. W. 1st Lieut., Engr. R. C., Co. C, 115th Engrs.

Currie, Thomas A., Jr. Private, 116th Engr. Detachment, A. P. O. 727, St. Aignan-Noyers, A. E. F., France.

Cushing, Edward B. Maj., Engr. R. C.; Supt., Army Transport Service, U. S. A. P. O. No. 705, A. E. F., France.

Cutler, Leon G. Capt., C. A. R. C., 57th Artillery, C. A. C., A. E. F., France.

Dallis, Park A. Capt., Engr. R. C.; Adjt., 24th Engrs.

Daly, A. P. V. 2d Lieut., 4th Connaught Rangers; 48 Cathcart Rd., London, S. W., England.

Daly, D. A. Capt., Engr. R. C., 16th Engrs., A. E. F., France.

Daly, John W. Lieut., Inf. R. C.

Danforth, George Clapp. Capt., Engr. R. C., 602d Engrs., A. E. F., France.

Darling, Clinton Stowell. 1st Lieut., 108th Engrs., A. E. F., France.

Darville, M. A. 2d Lieut., Engr. R. C., A. E. F., France.

Davidson, George B. 2d Lieut., Engr. R. C.

Davies, J. P. Capt., Ord. R. C.

Davis, Chandler. Capt., Engr. R. C., 6th Engrs., A. E. F., France.

Davis, Daniel E. 1st Lieut., Engr. R. C.

Davis, Frederick A. W. 1st Lieut., Co. E, 102d Engrs.

Davis, John C. Capt., C. A. R. C.

Davis, Robert M. 1st Lieut., Engr. R. C., 57th Engrs. (Inland Waterways).

Davy, J. J. 1st Lieut., 23d Engrs.

Day, Warren E. Capt., Engr. R. C.

Dean, Bertram D. Capt., Engr. R. C., Dept., C. and F., Headquarters, S. O. S., U. S. M. P. O. 717, A. E. F., France.

Dean, Willis J. 1st Lieut., Q. M. C., N. A.

de Charms, Richard, Jr. 1st Lieut., Engr. R. C., Co. A, 503d Engrs. (Service Bn.), A. E. F., France.

Dedicke, E. C. 2d Lieut., U. S. A.

Deiser, Norman A. 1st Lieut., Engr. R. C.

De Leuw, Charles E. 1st Lieut., Engr. R. C., 4th Engrs.

De Moss, Samuel. Private, School of Meteorology, Sig. C.

Dennis, William F. Maj., Engr. R. C. (*Unassigned*).

Dent, Elliott J. Col., Engrs., N. A., 26th Engrs., A. P. O. 765, A. E. F., France.

Derby, George McC. Lt.-Col., Corps of Engrs., U. S. A.

Diesem, Harry C. Capt., Engr. R. C., 404th Engr. Depot Detachment.

Diffenderfer, Claude O. Capt., Engr. R. C., 534th Engrs., A. E. F., France.

Dillman, George L. Maj., Engr. R. C

Dobson, Gilbert C. Capt., Engr. R. C., 314th Engrs.

Dodd, Joseph H. L. 2d Lieut., B. W. I. Regt.; Burlington, St. Margaret's Bay, Jamaica.

Doebler, Valentine S. Capt., Q. M. R. C.

Doeleman, H. F. Maj., Q. M. C., N. A.

Dohm, Edward Clarence. Capt., Engr. R. C.

Doten, Leonard S. Capt., Q. M. R. C.

Douglass, Louis R. Capt., Q. M. R. C.

Dow, Hezekiah Shailer. 2d Lieut., 492d Constr. Squadron, Air Service, A. E. F., France.

Doyle, John S. Capt., Engr. R. C.

Drayton, Newbold. Corporal, Battery D, 108th F. A., 53d Art. Brigade, 28th Div.

Drew, C. D. Capt., 11th Engrs. (Ry.), A. E. F., France.

Drummond, William W. Capt., Engr. R. C.

Drury, William F. Capt., Engr. R. C.

Du Bois, George B. 1st Lieut., Engr. R. C., Commanding 6th Engr. Train, 3d Div., A. E. F., France.

Dunlap, Walter H. 1st Lieut., Engr. R. C., 109th Engrs.

Dunn, Beverly C. Maj., Corps of Engrs., U. S. A.

Dunshee, Bertram K. 1st Lieut., Engr. R. C., 316th Engrs.

Du Pré, Wallace Duncan. Lieut., Q. M. C., N. A., Mech. Repair Shop Unit No. 303.

Durham, Henry Welles. Maj., Engr. R. C., 41st Engrs., A. E. F., France.

Durham, Leicester. Capt., Engr. R. C., A. P. O. 733, A. E. F., France.

Dykeman, Conrad F. 1st Lieut., Engr. R. C., 116th Engrs., P. O. 733, A. E. F., France.

Eager, V. M. Capt., Q. M. C., N. A.

Eason, F. G. Capt., Engr. R. C., 317th Engrs.

Easton, Russell B. Capt., Engr. R. C.

Eckel, Edwin C. Capt., Engr. R. C., Headquarters, A. E. F., France.

Eddy, Albert C. Capt., 55th Engrs., A. E. F., France.

Eddy, Harold M. Asst. Civ. Engr., U. S. N. R. F. (rank of Lieut. (Junior Grade)).

Edgerton, G. E. Lt.-Col., Corps of Engrs., U. S. A.

Edmondson, Ralph S. 1st Lieut., 27th Engrs. (Min.).

Edwards, G. G. Capt., Engr. R. C., Co. F, 315th Engrs.

Elliott, J. W. Capt., Engr. R. C., Co. A, 602d Engrs.

Elliott, Malcolm. Lt.-Col., Engrs., U. S. A., 309th Engrs., 84th Div., A. E. F., France.

Elliott, Percival. Private, Co. D, 33d Engrs.

Ellison, Alexander H. 1st Lieut., Engr. R. C., 3d Bn., 20th Engrs. (Forestry).

Embury, Aymar, 2d. Capt., Engr. R. C., Camouflage Section, A. E. F., France.

Emerson, Raffe. Ensign, Flying Corps, U. S. N. R. F.

Endicott, Mordecai T. Civ. Engr., U. S. N. (rank of Rear-Admiral).

Enger, Arthur L. Capt., Engr. R. C.

Ernst, Oswald H. Maj.-Gen., U. S. A. (*Retired*).

Estes, F. E. Capt., 17th Engrs. (Ry.), A. E. F., France.

Everett, Ralph B. Private, Co. F, 23d Engrs., A. E. F., France.

Everham, Arthur C. Maj., Q. M. C., N. A.

Fahy, Joseph Augustine. Capt., Engrs., N. A., Co. D, 518th Engrs.

Fairchild, John F. Maj., Q. M. C., Brigade Headquarters, 1st Corps Troops.

Fairlie, John Walter. 1st Canadian Exp. Force (*Retired*).

Fairman, James Robert. Capt., Engr. R. C.

Falk, Myron S. Maj., Ord. R. C.

Farley, M. M. 1st Lieut., Engr. Corps, U. S. A.

Farrin, James M. Capt., Engr. R. C.; Adjt., 6th Bn., 20th Engrs., A. E. F., France.

Fassett, Earle W. 1st Lieut., Engr. R. C., 316th Engr. Train, N. A.

Feigel, John H. 1st Lieut., Engr. R. C., A. E. F., France.

Feiner, Mark A. Meteorological Section, A. S., Sig. C.

Feltham, Percy M. Capt., Engr. R. C.

Ferguson, Harry Foster. 1st Lieut., Engr. R. C., O. C. E. O., Adv. Sec., L. of C., A. P. O. 714, A. E. F., France.

Fernald, Gordon H. Capt., Engrs., N. A., Co. D, 304th Engrs.

Fickes, Clark R. Maj., Engr. R. C., A. E. F., France.

Fiebeger, G. J. Col., U. S. A., Headquarters, A. E. F.

Fifer, Frank P. Capt., Engr. R. C., Lines of Communications, A. E. F., France.

Finley, C. MacF. Capt., Engr. R. C., 503d Service Bn., A. E. F., France.

Finnell, Woolsey. Maj., Engr. R. C., 501st Engrs., U. S. A. P. O. 741, A. E. F., France.

Fischer, Charles, Jr. 2d Lieut., Inf. R. C., 308th Inf.

Fisher, George Joseph. 2d Co., 4th E. R. O. T. C., Camp Lee, Va.

Fisher, Janon. Maj., Engr. R. C., 522d Engrs.

Fisk, Clinton H. Maj., Q. M. C., N. A.

FitzGerald, C. C. Maj., Engr. R. C., 32d Engrs.

Fitzgerald, Gerald C. 1st Lieut., Engr. R. C., 319th Engrs.

Fitzpatrick, F. J. Capt., Engr. R. C., Co. C, Service Bn., 508th Engrs., A. E. F., France.

Flagg, Herbert J. Capt., C. A. C., N. G. U. S.

Flagler, C. A. F. Brig.-Gen., U. S. A., 5th F. A. Brigade, A. E. F., France.

Fleming, Burton P. Capt., Engr. R. C.

Flick, John K. Capt., Engr. R. C.

Flook, Lyman R. 1st Lieut., Ord. R. C.

Fogerty, Merton S. 34th Prov. Squadron, Aviation Camp, Waco, Tex.

Fogg, Alden K. Asst. Civ. Engr., U. S. N. (rank of Lieut. (Junior Grade)).

Follin, James W. 1st Lieut., San. C., N. A.

Fölling, B. N. Capt., Engrs., N. A.

Foote, Olney N. Lieut., Co. G, 322d Inf.

Ford, William Ellis. Capt., Engr. R. C.

Forster, Arthur Oscar. Capt., Q. M. C., N. A.

Fortney, C. Page. Capt., Engr. R. C.

Foster, Ernest H. Ensign, U. S. N. R. F.

Foster, Samuel D. 1st Lieut. and A. D. C., Headquarters, 53d Artillery Brigade.

Fouilhoux, J. Andre. Capt., F. A.

Fountain, Thomas L. Capt., Engr. R. C., Care, C. O., 17th Engrs. (Ry.), U. S. A. P. O. 701, A. E. F., France.

Fowler, Charles Worthington. 1st Lieut., Sig. R. C., A. S., Commanding 485th Aero Constr. Squadron, A. E. F., France.

Fox, Henry. Capt., Engr. R. C., 314th Engrs.

Fox, Stephenson W. Maj., Engr. R. C.

Frank, George Stedman. Lieut., Sig. R. C., A. S., A. E. F., France.

Franks, John B. 1st Sergeant, Co. C, 353d Inf.

Freeman, William B. Capt., Engr. R. C., Co. A, 509th Engrs. (Service Bn.)

French, F. C. Capt., Engr. R. C., 525th Engrs.

Friedman, Harry B. Lieut., Sig. R. C., A. S.

Fries, Amos A. Col., 30th Engrs., N. A.; Chf. of Gas Service, A. E. F., France.

Froiseth, Richard E. 1st Lieut., Engr. R. C.

Frost, Edward M. Asst. Civ. Engr., U. S. N. R. F.

Fry, Alfred Brooks. Capt., U. S. N. N. V.

Fyfe, James Lincoln. Maj., Q. M. C., N. A.

Gailor, Chester F. Maj., Q. M. C., N. A.

Galbreath, Albert W. 1st Lieut., Engr. R. C., Co. B, 12th Engrs. (Ry.), A. E. F., France.

Gallagher, Leonard Bruce. 2d Lieut., Engr. R. C., Ry. Transportation Corps, U. S. A. P. O. 717, A. E. F., France.

Galloway, John D. Maj., Engr. R. C., A. E. F., France.

Galvin, James Augustine. 2d Lieut., Engr. R. C. (*Unassigned*), U. S. Army P. O. No. 714, A. E. F., France.

Garnett, Benjamin J. 1st Lieut., Engr. R. C. (*Unassigned*), A. E. F., France.

Garrett, Robert P. Capt., Ord., U. S. A.

Gartensteig, Charles. Capt., Engr. R. C., 535th Engrs.

Gatens, Ray S. 1st Lieut., Engr R. C., Co. C, 42d Engrs., A. E. F., France.

Gausmann, Roy W. Capt., Engr. R. C., Co. D, 303d Engrs.

Gayler, E. R. Civ. Engr., U. S. N. (rank of Commander), Port au Prince, Haiti.

Geib, George Albert. Capt., Engr. R. C., Co. A, 527th Engrs., Service Bn.

Genung, J. H., Jr. Lieut., Engr. R. C.

George, Howard H. Capt., Engr. R. C., Co. E, 305th Engrs.

Getty, Lorenzo T. 1st Lieut., Sig. C., U. S. A., A. S., 75th Aero Constr. Squadron, A. E. F., France.

Gibbs, E. A. Maj., 15th U. S. Engrs. (Ry.), A. E. F., France.

Gibbs, William Wetmore. 1st Lieut., Engr. R. C.

Giesen, Walter E. Private, U. S. M. C., Co. 269, Bn. W.

Giesting, Frank A. Maj., Engr. R. C., 302d Engrs.

Giffels, William C. 1st Lieut., Engr. R. C.

Gilman, E. Dow. 1st Lieut., Engrs., N. A., 473d Engrs.

Gladding, James N. Capt., Engr. R. C. (*Unassigned*), A. E. F., France.

Glander, John Henry, Jr. Asst. Civ. Engr., U. S. N. R. F. (rank of Ensign).

Glazier, W. L. Maj., Engr. R. C.

Goddard, Leslie Drew. Capt., Engr. R. C.

Godfrey, Alex. H. Asst. Paymaster, U. S. N. R. F.

Godfrey, Stuart C. Lt.-Col., Engrs., N. A., Headquarters, 318th Engrs., A. E. F., France.

Goethals, George R. Lt.-Col., Corps of Engrs., U. S. A.

Golden, William A. Ensign, U. S. N. R. F., U. S. S. *Mary Alice.*

Goldsmith, Clarence. Maj., Q. M. C., N. A.

Gooch, Carl Joseph. Co. E, 32d Engrs.

Goodman, Benjamin. 1st Class Private, 447th Depot Detachment, Engrs., A. E. F., France.

Goodman, Leon. Capt. and Adjt., 109th Engrs., U. S. N. G.

Gordon, John Blake. Care, Chf. Engr. Officer, General Headquarters, A. E. F., France.

Gordon, Samuel. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Goss, O. P. M. Capt., Sig. R. C., A. S.

Gotwals, John C. Lieut., Corps of Engrs., U. S. A.

Gough, William J. Capt., Engr. R. C.

Gould, William T. Capt., Engr. R. C., U. S. Military P. O. 705, A. E. F., France.

Grady, Frank L. Sergeant, Co. I, 52d Pioneer Inf.

Graff, George W. 40th Co., 10th Tr. Bn., 155th Depot Brigade, Camp Lee, Va.

Grant, John R. Capt. and Adjt., Royal Engrs., H. Q., R. E., 24th Div., B. E. F., France.

Grant, Kenneth C. Capt., Sig. R. C., A. S., Headquarters, 499th Aero Squadron.

Grant, U. S., 3d. Col., U. S. A.

Gravell, William Henry. Capt., Engr. R. C., A. E. F., France.

Graves, E. M. Maj., Engr. R. C., 529th Engrs.

Gray, Earle P. 1st Lieut., Engr. R. C., 16th Engrs. (Ry.), A. E. F., France.

Gray, William B. Maj., Engr. R. C.

Green, Charles N. Maj., Engr. R. C.

Green, Clarence Jasper. 1st Lieut., Oregon Coast Artillery.

Green, F. W. Capt., Engr. R. C., 12th Engrs. (Ry.), U. S. Military P. O. 716, A. E. F., France.

Greene, F. S. Capt., U. S. N. A., Co. B, 302d Engrs.

Greenfield, Robert A. 303d Engrs.

Gregory, Luther E. Civ. Engr., U. S. N. (rank of Captain).

Gregory, William B. Maj., Engr. R. C., A. E. F., France.

Grehan, Bernard H. 1st Lieut., N. A., 312th Engrs.

Griffin, John Alden. Capt., Co. A, 316th Engrs.

Grigsby, Walter B. 1st Lieut., Engr. R. C., 9th Engrs. (Mounted).

Grindrod, Irvin S. 1st Lieut., Engr. R. C. (*Unassigned*).

Griswold, Harry T. 2d Lieut., C. A. C., N. G.

Griswold, Hector C. Asst. Civ. Engr., U. S. N. (rank of Lieut. (Junior Grade)).

Griswold, Lee S. Capt., Engr. R. C. (*Unassigned*).

Grodske, Walter J. Capt., Engr. R. C. (*Unassigned*).

Gross, Frederick H. 2d Lieut., Engr. R. C., Co. B, 303d Engrs.

Gross, Henry McC. 1st Lieut., 149th Div., Machine Gun Bn., A. E. F., France.

Grunauer, Mortimer. Headquarters Co., 304th F. A., A. E. F., France.

Gunther, Herman Dietrich. Co. B, 147th Inf.

Guppy, Benjamin Wilder. Maj., Engr. R. C., 14th Engrs. (Ry.), A. E. F., France.

Guptill, Joseph R. Private, Co. E, 23d Engrs., A. E. F., France.

Gutman, David. Maj., Engr. R. C.

Haas, Philip L. Capt., Engr. R. C.

Hains, Peter C. Maj.-Gen., U. S. A.

Halcombe, N. M. Capt., Royal Flying Corps, Egypt.

Haldeman, Walter S. Capt., Engr. R. C.

Hale, Richard King. Lt.-Col., 101st Field Artillery, A. E. F., France.

Hall, Benjamin M., Jr. 1st Lieut., Engr. R. C., Co. B, 26th Engrs., A. P. O. No. 701, A. E. F., France.

Hall, Charles L. Lt.-Col., Corps of Engrs., U. S. A., Headquarters, A. E. F., France.

Hall, Gilbert G. 1st Lieut., Engr. R. C., 20th Engrs.

Hall, Julius R. 1st Lieut., Engr. R. C., 515th Service Bn.

Hall, Louis W. Capt., Engr. R. C., Care, Director of Const. and Forestry, S. O. S., P. O. 717, A. E. F., France.

Hall, Oliver Antrum. Capt., Engr. R. C., 23d Engrs., U. S. A. P. O. 738, A. E. F., France.

Hall, Warren E. Capt., Engr. R. C., Co. D, 506th Engrs. (Service Bn.), Base No. 2, A. E. F., France.

Hallberg, Arthur S. 1st Lieut., U. S. N. R. F., U. S. S. *Quinnebaug.*

Hamilton, Edward P. 2d Lieut., F. A. R. C., 306th Field Artillery.

Hammond, John M. Capt., Q. M. C., N. A.

Hanavan, William L. 1st Lieut., 9th Inf.; Adjt., 2d Bn., A. E. F., France.

Hancock, Henry Sydney, Jr. Lieut., Royal Engrs.; Field Engr., First Corps, B. E. F., France.

Hanique, Jules E. Maj., Engrs., N. A., 537th Engrs., A. E. F., France.

Hannan, David E. Capt., Engr. R. C., A. E. F., France.

Hansen, Paul. Capt., Engr. R. C. Headquarters, Advance Section, S. O. S., Office of Chf. Engr., A. E. F., France.

Hapgood, Frederic H. Co. A, 26th Engrs., A. E. F., France.

Hardaway, Benjamin H., Jr. Maj., N. A.

Harding, Chester. Lt.-Col., Corps of Engrs., U. S. A., Balboa Heights, Canal Zone, Panama.

Harding, Ralph L. Capt., Engr. R. C., 35th Engrs.

Harley, Alfred F. Field Clerk, Engr. Corps, A. E. F., France.

Harmon, W. G. Capt., San. C., N. A.

Harrah, O. W. Capt., Engr. R. C., 319th Engrs.

Harris, F. R. Rear-Admiral, U. S. N.

Harris, Frank S. M. Lieut. (Senior Grade), N. N. V.

Harrison, William Burr. Maj., Engr. R. C.

Hart, S. A. 1st Lieut., Engr. R. C., 23d Engrs.

Harter, A. F. Capt., Engr. R. C.

Harts, William W. Brig.-Gen., N. A., G. H. Q., 1er Echelon, B. E. F., France.

Hasbrouck, Oscar. Capt., Engr. R. C., 522d Engrs.

Haskins, C. A. Capt., San. C., N. A.

Haskins, John C. 1st Lieut., Engr. R. C., 22d Engrs.

Hastings, R. P. 1st Lieut., Engr. R. C., Co. D, 26th Engrs.

Hatch, Frederick N. Capt., Engr. R. C., 35th Engrs., A. E. F., France.

Hauser, Kenneth D. Capt., 18th Engrs. (Ry.), A. E. F., France.

Hawley, John B. Maj., Engr. R. C., 503d Engrs., Service Bn., A. E. F., France.

Haydock, Charles. Co. 3, E. O. T. S., Camp Humphreys, Va.

Hayes, F. Eugene, Jr. Chf. Carpenter's Mate, U. S. N.

Hays, Donald S. Capt., Engr. R. C.

Hays, John Coffee. Maj., Q. M. R. C..

Hazlehurst, James Nisbet. Maj., Engr. R. C., Headquarters, S. O. S., A. E. F., France.

Healey, Charles F. Capt., Engr. R. C., A. P. O. No. 701, A. E. F., France.

Heck, Nicholas H. Lieut., U. S. N. R. F.

Heed, Samuel D. Capt., Ord. R. C.

Hendricks, Ernest D. Capt., Engr. R. C., Co. B, 303d Engrs.

Hendrie, John Gibson. Capt., Engr. R. C.; Adjt., 2d Bn., 318th Engrs. (Sappers).

Henning, Charles S., Jr. Master Engr., Co. A, 21st Engrs., A. E. F., France.

Henry, Earle Underwood. 1st Lieut., Engr. R. C., 116th Engrs., Care, D. G. T., A. P. O. No. 717, A. E. F., France.

Herkness, Lindsay C. Lt.-Col., Corps of Engrs., U. S. A., 302d Engrs.

Herzig, Solon. 1st Lieut., Engr. R. C., Co. F, 25th Engrs., A. E. F., France.

Heslop, D. G. Capt., Royal Engrs., O. C. Surveys, Light Rys., E. E. F., Palestine.

Heuer, W. H. Col., U. S. A. (*Retired*).

Hewett, M. W. 1st Lieut., Engr. R. C., 508th Service Bn.

Hews, Wellington P. Capt., Engr. R. C., 62d Engrs., A. E. F., France.

Hickok, Clifton E. Capt., Engr. R. C.

Higgins, Charles H. Maj., Ord. Dept., U. S. A.

Hilder, Frazer C. Capt., Engr. R. C., Goring Hotel, Grosvenor Gardens, London, W. 1, England.

Hiles, Elmer K. Maj., 15th U. S. Engrs. (Ry.), A. E. F., France.

Hilton, Harry L. Asst. Civ. Engr., U. S. N. R. F.

Hirzel, Alfred Sparks. Capt., 1st Delaware Inf.

Hjorth, Lawrence R. Co. C, 302d Field Sig. Bn.

Hoad, William C. Maj., Sig. C., N. A.

Hoar, Allen. Civ. Engr., U. S. N. R. F.

Hobbs, Henry W. Maj., Engr. R. C.

Hodge, Henry W. Lt.-Col., R. T. C., N. A.; Mgr. of Roads, G. H. Q., A. E. F., France.

Hodges, H. F. Maj.-Gen., N. A.

Hoffman, Eugene R. Private, Headquarters Detachment, 26th Engrs., A. E. F., France.

Hogan, John P. Capt., 11th Engrs. (Ry.), A. E. F., France.

Holborn, Lewis A. Lieut., 22d Engrs.

Hollyday, R. C. Civ. Engr., U. S. N. (rank of Captain).

Holstlaw, Charles Henry. 1st Lieut., Inf. R. C., 124th Inf.

Holt, Andrew H. Capt., Engr. R. C.

Honeyman, Bruce R. Capt., Engr. R. C., Co. A, 313th Engrs.

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Hopkinson, George Martin. Capt., Q. M. C., N. A.

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Howard, Conway Robinson. 1st Lieut., 17th Engrs. (Ry.), A. E. F., France.

Howard, Gerald B. 1st Lieut., Engr. R. C., Co. E, 17th Engrs. (Ry.), A. E. F., France.

Howard, Robert C. Capt., Engrs., U. S. A.

Howe, Wilson Tyler. Capt., Q. M. C., N. A.

Howell, Clarence S. Capt., Engr. R. C.

Howell, George P. Col., Corps of Engrs., U. S. A.

Howell, Robert P. Capt., Q. M. C., U. S. A.

Hoxie, Richard L. Brig.-Gen., U. S. A. (*Retired*).

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Huber, William T. Capt., Engr. R. C.

Hudson, H. W. Maj., Staff of Director-Gen. of Transportation, Care, Director-Gen. of Transportation, A. E. F., France.

Hughes, George L. 2d Lieut., Engrs., N. A.

Huie, Irving V. A. Capt., Co. B, 1st Engrs., U. S. A., A. E. F., France.

Hull, George B. Maj., Canadian Forestry Corps, Care, C. H. Orme, Prince Rupert, B. C., Canada.

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Hulsart, C. Raymond. Capt., Co. B, 11th Engrs. (Ry.), A. E. F., France.

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Humphrey, Gilbert Edwin. Maj., Corps of Engrs., U. S. A.

Humphreys, Charles Raymond. Capt., 105th Engrs.

Humphreys, Ewing S. 1st Lieut., Engr. R. C.

Hunt, Charles A. Civ. Engr., U. S. N. R. F.

Hunt, Conway B. Maj., Engr. R. C. (*Unassigned*).

Hunt, Leigh A. Maj., 110th Engrs., A. E. F., France.

Hurlbut, H. B. Capt., Ord. R. C.

Hurley, John Patrick. Capt., Co. K, 165th Inf., A. E. F., France.

Husson, William M. Capt., 82d U. S. Field Artillery.

Husted, Alva Guy. Capt., San. C., N. A.

Huston, Tillinghast L'Hommedieu. Maj., Engr. R. C., 1st Bn., 16th Engrs. (Ry.), A. E. F., France.

Hyde, Charles G. Capt., San. C., N. A., Bn. 7, Co. 28.

Hyde, Richard Lewis. 2d Lieut., Engr. R. C., 10th Engrs., A. E. F., France.

Hynds, Harold D. 1st Lieut., Sig. R. C., A. S.

Ingalls, O. L. Maj., Engr. R. C.

Irish, Leland W. Master Engr., 42d Bn., 20th Engrs.

Jackson, Dugald C. Maj., Engr. R. C., A. E. F., France.

Jackson, Jesse A. Maj., 116th Bn., 41st Div., Sig. C.

Jackson, W. B. Maj., Q. M. C., N. A.

Jacobosky, Gilbert G. Capt., Co. B, 55th Engrs., A. E. F., France.

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James, Alfred R. 1st Lieut., Q. M. C., N. A.

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King, Eric T. Maj., Q. M. C., N. A.

King, Howard L. 2d Lieut., Engr. R. C., Co. B, 27th Engrs.

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Knost, W. A. 1st Lieut., C. A. R. C.

Koop, Louis D. Capt., Q. M. C., N. A.

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Lockwood, Richard J. 2d Lieut., F. A., U. S. N. A.

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McClure, Hunter. 1st Lieut., Engr. R. C.

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McDonald, Harry L. Capt., Engr. R. C.

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McGeehan, Paul. Capt., Co. D, 12th Engrs. (Ry.), A. E. F., France.

McGlathery, Sam L. Capt., Engr. R. C., 312th Engrs.

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McGrew, John A. Maj., Q. M. R. C.

McIntosh, Samuel F. Capt., Ord. R. C.

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Newhall, William Barrett. Capt., Engr. R. C.

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Noska, G. A. Capt., Engr. R. C., 303d Engrs. (Sappers).

Nowlin, Robert A. 2d Co., E. O. T. S., Camp A. A. Humphreys, Va.

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Odoni, Vincent P. Ensign, U. S. N. R. F.

Okes, Day I. Capt., Engr. R. C., and Adjt., 42d Engrs.

Olberg, Charles R. Capt., Engr. R. C.

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Reed, Paul Lyon. Civ. Engr., U. S. N. (rank of Commander).

Reeder, Harry C. 1st Lieut., Engr. R. C.

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WATKINS, FREDERICK WILLIAM. Elected Member, October 3d, 1883; died August 20th, 1918.

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(9) *Industrial Management,* New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, 432 Fourth Ave., New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News-Record,* New York City, 15c.
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PAPERS AND DISCUSSIONS

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DETENTION RESERVOIRS WITH SPILLWAY OUTLETS AS AN AGENCY IN FLOOD CONTROL

Discussion.*

By Morris Knowles, M. Am. Soc. C. E.

Mr. Knowles.

Morris Knowles,† M. Am. Soc. C. E. (by letter).‡—The writer cannot but be deeply conscious of the honor conferred upon him by the request that—in behalf of the late Gen. Chittenden—he prepare the closure of the discussion on this paper. In acceding to this request he will endeavor to assume the attitude of the author, in so far as possible, aided by his familiarity with, and deep appreciation of, the latter's concepts on this subject, and by the fact that he is, and has long been, in accord with the aims expressed herein by Gen. Chittenden. The writer, however, is humbly impressed by his inability to interpret adequately the author's breadth of view and do justice to what has unexpectedly become a valedictory. The loss of Gen. Chittenden from the ranks of the Profession is indeed a serious one. It is to be regretted that so prolific a writer, with a mind so active and clear, should not have been permitted to be longer with us to take part in the development and witness the fruition of works that will undoubtedly be built in the near future in the attempt to solve this great problem of stream regulation.

Without doubt, Mr. Morgan has aptly caught and expressed Gen. Chittenden's purpose in presenting this paper, in that it is a plea

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* Discussion of the paper by the late H. M. Chittenden, M. Am. Soc. C. E., continued from August, 1918, *Proceedings*.

† Pittsburgh, Pa.

‡ Received by the Secretary, September 7th, 1918.

This closing discussion on the paper by the late Gen. Chittenden has been prepared by Mr. Knowles in compliance with the request of the Publication Committee.—[Secretary].

Mr. Knowles. to the Profession to "keep open a field of opportunity", in flood control, for the use of dual purpose reservoirs. The author's great openness of mind, as expressed by his willingness to change opinions when convinced after thorough study, is clearly stated by Mr. Morgan, in relating the circumstances surrounding the early investigations at Dayton, to which the writer can testify, for he was present as one of the group of "several other engineers"; and there is no better illustration of Gen. Chittenden's kindly, generous nature, which all who knew him learned to admire, than his statement on page 1437,* when referring to the dual use of storage reservoirs:

> "The writer would bespeak for the idea thus doubtfully referred to in the last two citations a more thorough and friendly consideration than has yet been given it. May not the superposition of one reservoir upon another contain important possibilities after all?"

To many, the consideration has become difficult and involved, because they have not kept clearly in mind the fact that dual use does not generally (and only in exceptional circumstances) contemplate control of the same volume of storage. In fact, as the author pointedly remarks, on page 1425:*

> "It is further generally recognized that flood control and storage for use are essentially antagonistic purposes which make impossible a reliable utilization of the same reservoir space for both."

It is well to remember that even the illustration of the Colorado River, so carefully and technically treated by Mr. Petterson, may be considered an exceptional instance, and not one of general application. Mr. Houk forcibly calls attention to this latter thought, in his analysis of the above mentioned discussion, with his illustration of the Miami River flood records. The author says, again, on page 1436:*

> "The question is not that of joint use of the same identical reservoir space, but that of having space for each purpose in addition to that required by the other. This, in fact, is the crux of the physical problem."

In the opinion of the writer, the "field of opportunity" seems so near to attainment, promises such obvious desiderata as to results, and such progress has been made toward its realization as a valuable method of flood control—both in theory and in the actual building of works—that to condemn the idea now, on the basis of our existing incomplete information and still more scant trial, would indeed be most unfortunate and ill considered. As the author has so well stated:

> "Better by far to take some chances and register progress than to block progress because of contingencies which are so remote as to be practically negligible."

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* *Proceedings*, Am. Soc. C. E., September, 1917.

Mr. Knowles

The paper can in no sense of the word be regarded as a critique of "Detention Basins" or of "Reservoirs" as agencies for flood control. Indeed, in pointing out that the possibilities are not yet exhausted, the author has ingeniously proposed merely to superimpose a "detention basin" upon a reservoir—the former for purposes of flood control and the latter for such purposes as might otherwise be intended. Such a detention basin would then begin with the advantage of large area, as the greatest area of the reservoir is obviously its upper surface. Again, it would have all the advantages of the detention basin founded directly on the valley floor, as to conservation of land values within the flooded area, for it must be quite plain that the damage due to the land being flooded permanently by the reservoir should be charged against the purpose for which the reservoir is to be used—whether that purpose be the production of power, municipal water supply, whether for navigation or irrigation, or what not. The author expressly makes reservation, moreover, that he is not proposing a cure for all flood problems, but rather an application which may be useful in an "indeterminate zone of great extent" in harmonizing industrial and commercial uses, and flood control, in those cases where reservoirs can be made available for these purposes. Mr. Meyer's discussion of the very interesting case in point, of several uses at an unusually favorable site, seems quite apropos.

Nor can Gen. Chittenden's paper be considered a brief in favor of spillways *versus* conduits or orifices, in the automatic control of flood storage. The writer agrees with Mr. Morgan in that the author has purposely avoided the discussion of details—contenting himself simply with pointing out possibilities in substantiation of his original plea. Yet, are there not cases where spillways or spillway channels may automatically control the discharge of floods to the best advantage? Are not the relative merits of spillways, as contrasted with conduits for this purpose, affected to a major degree by the proportionate area of the reservoir in comparison with its water-shed? No one would think, for instance, of advocating conduits for flood storage in Lake Superior, to which Gen. Chittenden forcibly refers; and the writer can picture circumstances wherein artificial reservoirs of large area topped with a detention basin, as suggested, might be controlled to advantage simply by a spillway channel of proper proportions.

Mr. Petterson presents a most technical discussion of his thesis—that the same volume of storage may be used, in some instances, for different purposes, namely, to prevent floods and to increase stream flow at other times for valuable industrial purposes. It is sufficient to say that the detailed and rather abstruse mathematical work, as well as the basic data, in the paper* by Allen Hazen, M. Am. Soc. C. E., are of interest to the student of the subject, and are worthy of close study.

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* *Transactions*, Am. Soc. C. E., Vol. LXXVII (1914), p. 1539.

Mr. Knowles. Notwithstanding the reservation, which must be borne in mind, that there is danger in too general applicability, the calculations bear the evidence of correctness, and, though the premises are not broad enough to warrant so determinate a deduction, our judgment tells us that, with relatively uniform seasonal occurrence of floods, such use may be most advantageous.

Mr. Hall's interesting tabulation of the Ohio River floods is in line with Mr. Petterson's discussion of the Colorado project, namely, that dual use of some storage does not necessarily conflict in all cases. At least, according to the theory of probabilities, there is a large chance to use for many years much of the same storage space for both flood prevention and industrial purposes. The report of the Pittsburgh Flood Commission, published in April, 1912, shows, in a like manner, that 65.9% of the floods in the Ohio River, at the junction of the Allegheny and Monongahela, occur, during the years of record, in the months of January to March, inclusive, and that, during the remainder of any year, only one flood occurred exceeding 4 ft. above flood, or overflow, stage. No floods are recorded in September and October during the 105 years under observation.

Mr. Tibbetts calls attention to a somewhat different application of the detention basin principle due to the peculiar topographical conditions of the Sacramento Valley. His discussion of comparative costs and the use of appliances in different parts of the country, however, does not seem to be germane to the subject. The writer recalls that there were certain physical and hydraulic conditions which pointed toward the general inapplicability of the levee system in the Miami Valley, in addition to the problem of its excessive expense. The last sentence of Mr. Tibbett's discussion, however, expresses the truism: that each place and district has its own particular problem, governed by local conditions, demanding for each, therefore, a separate and distinct solution.

Capt. Grant refers to two important continental examples of the use of the "same reservoir space * * * for flood control and for other purposes." This is a valuable contribution to the discussion, presented in his usual clear and concise manner. The statement with regard to mechanical control *versus* automatic regulation is also pertinent, in showing that we must still keep our minds open, and study for the optimum means for each case or group of conditions. No greater truth has been presented than the following:

> "If the time is not ripe for carrying out all parts of the project, the works should be designed so that additions for the other purposes can be made at a later date."

It is important that we should bear this in mind at the present time, when, under the stress of present conditions, we are inclined

Mr. Knowles.

to do only that work which is essential and for which money can properly be utilized now. On the other hand, far-sighted vision demands that what is done now shall be of such basic design and strength that superimposed structures may be added later when the need of other uses makes it wise to build; and the essential steps of investigation, and study and collection of data, are important as a preliminary agency.

Gen. Chittenden's suggestion has served to prove his point, namely, that the field can by no means be considered closed to the successful use of dual purpose reservoirs—we must still keep an open mind. In this view, indeed, the writer concurs with the author, having expressed such a conviction in the Minority Report of the Special Committee on Floods and Flood Prevention.*

The subject of ways and means for the control of floods is by no means exhausted. In fact, there is still a paucity of information on fundamental phenomena. Floods and their control present a complexity of situations and conditions involving many different sciences, each a broad study in itself; and, as Gen. Chittenden has so often and so ably pointed out, not the least of these difficult conditions is the human factor. At best, it is not easy to impress the public mind with the advantages and importance of spending money on works for flood control and the necessary thorough, preliminary investigations; and any improvement or suggestion which will tend to harmonize the industrial use of works with flood prevention—to increase the dollar efficiency of the investment, even at the expense of a slight decrease in efficiency of flood control—will go far toward needed progress in this direction.

The discussion of the development of hydro-electric power at sites used for flood storage is particularly apropos at this time, when there is an unusual demand for electric energy, especially in industry where steam power is at present inadequate to furnish all the energy needed for war purposes, and at a time, also, when the difficulty of securing enough coal is a very pressing problem. National consideration of the development of water power becomes more prominent from day to day, and will continue to press for a broad and sane solution. Will not the possibilities of the dual use of reservoirs offer an inviting field, and make more promising the development of some sites formerly on the border line of financial desirability?

Mr. Thomson strikingly refers to the enormous saving in coal that would accrue as a result of one proposed development. He also points to the fact that we do progress, and finally sift out the good in engineering practice, to which we may cling. The monetary discussion by Mr. Morgan on page 2001,† giving reasons for not considering it wise

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* *Transactions*, Am. Soc. C. E. Vol. LXXXI (1917), p. 1232.

† *Proceedings*, Am. Soc. C. E., November, 1917.

Mr. Knowles. to add water power to the Miami Conservancy project, is interesting; but, with the changing values now and as time goes on, perhaps the balance will be sufficiently shifted to make such dual development worthy of consideration.

We are on the eve of a vast development and control of our natural resources, and, of these, water is one of the greatest. Unquestionably, much of the future greatness of America will be determined by the degree of wisdom with which we provide a comprehensive solution of this important problem of stream regulation so as to secure all the possible good and energy out of running water and control its devastating power. Frankly, the danger in the situation at present is the attempt to standardize on works or designs, in a field characterized by many remaining indefinite factors, after the remarkable controversies of years. Crystallization should not be attempted until opinions and data on the problem of reservoir control have become more concentrated and stable. As Gen. Chittenden wisely held, we would do well to postpone final conclusions until the evidence is complete, or, at least, has been more thoroughly collected and studied.

AMERICAN SOCIETY OF CIVIL ENGINEERS
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THE ECONOMICS OF STEEL ARCH BRIDGES

Discussion*

By Henry S. Jacoby, Assoc. Am. Soc. C. E.

Mr. Jacoby.

Henry S. Jacoby,† Assoc. Am. Soc. C. E. (by letter).‡—The author deserves the hearty appreciation of the Profession for offering for publication the results of his elaborate investigations on certain economic relations of steel arch bridges. Only those who have undertaken similar work can comprehend what a vast amount of labor was involved.

Since the construction of the two arch bridges over the Niagara River, completed in 1897 and 1898, respectively, steel arches have been a subject for original investigation by many graduate students and some undergraduates in the Bridge Department of Cornell University. Brief statements of some of the most important results have been published.§

In order that the results might have more than an academic interest, actual designs have been used as the basis for comparative designs made under various conditions, in order to determine the relative weights and deflections of steel arches of different types.

A comparative study of different steel arch bridges actually built may not permit definite conclusions to be drawn in regard to economic

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* Discussion of the paper by J. A. L. Waddell, M. Am. Soc. C. E., continued from August, 1918, *Proceedings*.

† Ithaca, N. Y.

‡ Received by the Secretary, September 4th, 1918.

§ "Text-Book on Roofs and Bridges", by Merriman and Jacoby, 3d ed., Part IV, Arts. 85, 92-95.

Discussion on paper by C. W. Hudson, M. Am. Soc. C. E., entitled "Comparison of Weights of a Three-Hinged and a Two-Hinged Spandrel-Braced, Parabolic Arch", *Transactions*, Am. Soc. C. E., Vol. XLIII, p. 34.

An article on the design of a two-hinged arch rib, *Transactions*, Assoc. Civ. Engrs. of Cornell Univ., Vol. VII (1898-99), p. 89.

An article on an investigation of comparative deflections of steel arch ribs with three, two, and no hinges, by Mr. Phoo Hwa Chen, *Cornell Civil Engineer*, Vol. XXVI (Feb., Mar., 1918), pp. 184, 229.

Mr. Jacoby.

design, because the loading, unit stresses, and other items of the specifications differ materially, and there are variations likewise in the form and proportions of the arches, and in the type and weight of floor systems. It is instructive, however, to consider certain facts related to past practice in the construction of steel arch bridges.

Eleven years ago Mr. C. H. Mallison compiled a table of about eighty American bridges containing metallic arches, with spans varying from 33 to 840 ft. About 85% were highway bridges. A study of this list shows that the number of arch bridges with three hinges is very nearly equal to the sum of those containing two or no hinges. In those with three hinges there are from three to four times as many having open webs as solid webs, and, for those without hinges, this relation is reversed in nearly the same proportion. Of the arches with two hinges, the number having open webs is more than two-thirds as large as those with solid webs. Of the arches having open webs, more than three-fourths of the three-hinged arches are spandrel-braced, but only one-half of the two-hinged arches are of that construction. It would be interesting to know whether these general relations have been changed materially by the bridges built during the past decade.

Of the eighty bridges referred to, 25% have a span of less than 100 ft., 35% from 100 to 200 ft., about 20% from 200 to 300 ft., and about 20% have a span of more than 300 ft. The large number of short spans is due to the fact that steel arches have been used in parks and in cities where esthetic rather than economic reasons governed the choice of the type. In general, as the spans decrease in length, the use of solid webs increases.

Mr. Mallison found the proportions to be as given in Table 11, all values being expressed as percentages.

TABLE 11.

No. of hinges.	Character of web.	Ratio of Rise to Span.			Ratio of Crown Depth to Span.		
		Max.	Min.	Average.	Max.	Min.	Average.
3	Open.......	37.5	9.5	18.3	6.0	1.3	3.1
3	Solid.......	30.3	8.2	15.3	5.1	1.3	3.2
2	Open.......	27.8	7.1	17.6	6.7	2.2	3.7
2	Solid.......	28.6	8.0	14.1	4.2	1.9	2.7
0	....	21.7	7.0	12.2	6.1	1.4	2.8

As the maximum values for the rise range from nearly four to about three times the corresponding minimum values, the effect of local conditions at the sites is indicated clearly. It will be noticed that the average values are highest for arches with three hinges and lowest for those without hinges.

Mr. Jacoby.

The great range in crown depth from maximum to minimum seems hardly to be justified, either by economic considerations or local conditions, and serves to show the need for such investigations as have been made by Dr. Waddell.

On comparing the values in Table 11 with those determined by the author on the basis of economy only, it appears as if the latter values may serve a useful purpose as maximum limits when making a design for any particular locality.

Slightly more three-hinged arches have parabolic chords or axes than circular ones, but, for two-hinged arches, this relation is reversed. Nearly all the arches without hinges have circular axes or chords. Apart from the curves named, the straight line, hyperbola, and ellipse are used in only a few exceptional cases. The modern tendency is to increase the use of the parabola.

Eighteen years ago, in discussing a paper on spandrel-braced arches, by C. W. Hudson,* M. Am. Soc. C. E., the writer recommended that two-hinged arches be designed and erected so that the dead-load stresses would be distributed as in three-hinged arches, and the live-load, impact, and temperature stresses as in two-hinged arches. This is accomplished by closing the arch with a temporary hinge and afterward transforming it into a two-hinged arch, at the proper temperature, when the structure is otherwise complete. In a spandrel-braced arch, this can be done by inserting the final member, without stress, at the mean temperature, and by riveting the connecting plates where the temporary hinge is located. By thus eliminating stresses due to inaccuracies in shop work, and due to erection, a higher degree of economy may be secured. It is gratifying to observe that this method has been used in practice in a number of notable examples. In some cases, however, the transformation to the two-hinged type was made before the floor system was put in place.

A study was made by Mr. R. W. Parkhurst to ascertain the influence of the position of the crown-hinge on the deflections of a three-hinged, spandrel-braced arch. For this purpose he used special designs based on the proportions and loads of the Niagara Arch Bridge, having a span of 550 ft. There are sixteen panels in the span. For convenience, let *B*, *I*, and *T* represent the three cases when the crown hinge is in the bottom chord, intermediate between the chords, and in the top chord, respectively. At Panel point 4, the quarter point of the span, the deflections under full live load are found to be 22 and 72% greater for Cases *I* and *T* than for Case *B*. At Panel point 6, the deflection for Case *I* is very slightly less and for Case *T* slightly greater than for Case *B*. At Panel point 8, the center of the span, the deflections for Cases *I* and *T* are, respectively, 40 and 55%

***Transactions*, Am. Soc. C. E., Vol. XLIII (1900), p. 34.

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less than that for Case *B*. The best form of deflection curve is given when the crown-hinge is between the top and bottom chords.

For a concentrated load placed at the center of the span, the deflections for Case *I* are intermediate between those of Cases *T* and *B* at all panel points, the greatest deflections being those of Case *B*. At Panel point 8 the deflections for Cases *I* and *T* are, respectively, 27 and 42% less than that for Case *B*.

When a concentrated load is placed at Panel point 4, the quarter point of the span, the differences between the deflections throughout the span are comparatively small. At the load the deflection for Case *I* is almost midway between those of Cases *B* and *T*, that for Case *T* being the largest. At Panel point 8, the center of the span, the deflection is downward for Case *B* and upward for Cases *I* and *T*. At Panel point 12, the third quarter point of the span, all the deflections are upward, that of Case *I* being the largest, and that of Case *T* being the least.

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DISCUSSION ON
FINAL REPORT
OF THE SPECIAL COMMITTEE
ON CONCRETE AND REINFORCED CONCRETE*

By J. R. Worcester, M. Am. Soc. C. E.

Mr. Worcester.

J. R. Worcester,† M. Am. Soc. C. E. (by letter).‡—Mr. Bissell§ has approved the point in the discussion‖ by A. H. Rhett, Assoc. M. Am. Soc. C. E., which is based on a fundamental error, namely, that in the "ideal beam, the resisting moment of compression * * * must equal the resisting moment in tension." He also states that "this condition is realized by the use of the 'steel ratio for balanced reinforcement.'"

The first of these statements can be easily disproved by the following considerations:

If the moment of compression is equal to the moment of tension, as the total compressive stress must equal the total tensile stress, the lever arms, from the neutral axis to the centroid of compression, must equal that from the neutral axis to the center of the reinforcement. This is the case only where $K = \frac{3}{5}$ and $\frac{F_s}{F_c} = \frac{2}{3} n$. Such a ratio is highly inconsistent with "balanced reinforcement" and with the stresses assumed by Mr. Bissell in his examples.

The second statement, as to "balanced reinforcement", is due clearly to a misunderstanding of the term. This might have been

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* Continued from August, 1918, *Proceedings*.

† Boston, Mass.

‡ Received by the Secretary, September 4th, 1918.

§ *Proceedings*, Am. Soc. C. E., August, 1918, p. 897.

‖ *Transactions*, Am. Soc. C. E., Vol. LXXXI (1917), p. 1155.

Mr. Worcester.

made clearer in the report of the Committee. It merely means a sufficient quantity of reinforcement, so that the stress in the steel shall bear the same ratio to the maximum stress in the concrete as the maximum stresses in the two materials allowed by the specifications. This condition, although it leads to using the two materials economically, is by no means generally desirable. Many conditions may make it desirable to use less steel than the maximum which might be allowed. Generally speaking, the stress in the steel is what governs the design, rather than the stress in the concrete; that is, the concrete will be stressed to much less in compression than it might safely carry; but, on the other hand, it not infrequently occurs that the stress in the concrete will be the controlling feature, and that an excess of steel will be desirable.

MEMOIRS OF DECEASED MEMBERS

NOTE.—Memoirs will be reproduced in the volumes of *Transactions*. Any information which will amplify the records as here printed, or correct any errors, should be forwarded to the Secretary prior to the final publication.

DON JUAN WHITTEMORE, Past-President, Am. Soc. C. E.*

DIED JULY 16TH, 1916.

Within the lifetime of Don Juan Whittemore the Engineering Profession progressed from an unrecognized and unorganized state to the first rank among those now established as learned professions. At the time of his birth there were but few broad-minded men who realized the necessity for increasing the facilities for transportation and industrial production in America or who had visions of the advantages to be derived through improvements in machinery and transportation. Some of these few became our first civil engineers. They had foresight and natural ability, courage and perseverance, and were inspired by patriotism and ambition. At the date of his birth, engineering was not a known profession. Those who practised it and became its founders in America were usually self-educated and skilled in some form of manual work, and their knowledge was further increased through acquaintance with each other's efforts. It was a year before his birth that civil engineering was first taught in a school, and it was not until he was twenty-two years of age that the first organization of American engineers was established. This organization, of which Mr. Whittemore was later a most distinguished member, is the American Society of Civil Engineers.

Being actively engaged in engineering work for more than sixty years from 1847, and a close observer, Mr. Whittemore became a potent factor in bringing the Profession of Civil Engineering to its present position of importance and usefulness. He was pre-eminently a railroad engineer, engaged in railroad surveys, construction, and maintenance, and as such did his full share, for a longer period than is granted most engineers, in the development of internal transportation. This is a sufficient field of effort for any one man, and though it occupied his practical activity, it should be recorded that he was always a discriminating student and a patient investigator, and attained an unusual store of knowledge of a wide range of engineering.

A memoir of Mr. Whittemore's life and work would be of historical and professional value if it could be written fully and correctly. Unfortunately for this record, it is found that his peers, who could have supplied the data for such a memoir, have preceded him into that country which is obscured from our vision, and it is left to the compilers to enter such fragmentary accounts as are now available, and to supplement them from memory, which does not reach backward to the early part of his working life.

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* Memoir prepared by Charles F. Loweth, M. Am. Soc. C. E., and Onward Bates' Past-President, Am. Soc. C. E., for the American Society of Civil Engineers and the Western Society of Engineers.

A brief summary of his career, dictated by himself in 1909 for family record, and not revised nor intended for publication, is introduced here, for the reason that his own words, uttered without restraint, will be esteemed of more value than those of another giving the same information:

"I was born in Milton, Vermont, at a little hamlet called Checkerberry Green, December 6th, 1830.

"Parents: Father, Albert Gallatin Whittemore, Lawyer; Mother, Abby Clark Whittemore.

"My first school teachers were Sarah and Lovisa Wright (two giants in height, and mentally strong). Afterward one 'Nerrit', an Irishman and a famous instructor, followed by one Johnson, a collegian, and Dr. F. B. Hathaway, also a superior teacher. At about fourteen years of age my father placed me in school in St. Albans under the tuition of Friar Lawrence, so-called. I also spent a short term in Georgia School. At St. Albans boarded at John Burgess'.

"I then went to Bakersfield, where there was a celebrated school and teachers, the principal being Jacob Spaulding, a famous teacher. I remained there some time.

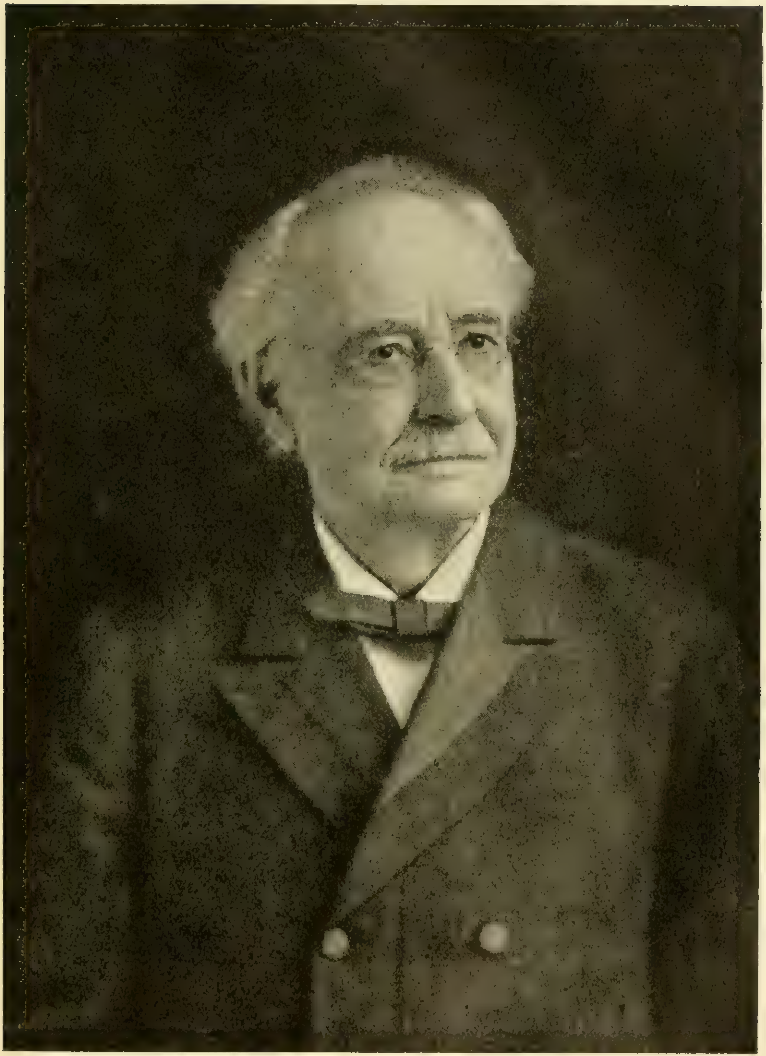
"Great credit is due my father for his home instruction, he being a natural student, linguist, lawyer, and surveyor. He took great pains in the education, morals, and habits of his children. As I showed a fondness for mathematics and mechanics he secured me a position as surveyor on the Vermont Canada R. R. (in last of 1847), extending from Essex Junction to Rouse's Point, under Phaon Jarrett (a German), Division Engineer, the President of the road being Henry Campbell, of Pennsylvania, at that time called 'Old Whitey', being only forty years of age and white-haired.

"During this time the first trestle bridge ever built for railroads was erected on Missiquoi Bay between Alburg and Swanton, also a pontoon bridge at Rouse's Point in 1849-50. Was Division Engineer at this time.

"In 1851 went on to the Great Western Railroad, Niagara Falls to Windsor, with position as Resident Engineer.

"In 1852, my father being anxious to have me engage with the Ohio Central, he with others under the firm name of Bradley, Whittemore, Thos. Chittenden and Co., I decided to visit him and see what the prospects of employment were, and whether it was best to go. November 10th, 1852, the next day after my arrival, while I and my father were examining public works of Zanesville, by a fearful accident my father was deprived of his life, and I barely escaped the same fate.

"After his death and removal to the old home in Milton, Vermont, I returned to Ohio, after going back to the Great Western to close my engagement there, and engaged with the Ohio Central Road leading



D J Whittemore

from Wheeling, Virginia, to Columbus—over one hundred miles. My position there was contractor's engineer, representing the estate of my father, the Company then being John Bradley, Norman L. Whittemore, and Thomas Chittenden. I remained there from November to July, 1853.

"This Company took a contract from Milwaukee to Portage City, now a part of the La Crosse Division of the Chicago, Milwaukee and St. Paul Railway, and I was then appointed assistant to the Chief Engineer, Byron Kilbourn, which position I occupied until 1857, when I left and engaged with the same company on the La Crosse and Milwaukee Railroad. Road failed, but company paid the debts—unable to go on.

"From 1857 to 1859 was Chief Engineer of the Southern Minnesota Railroad, running all over the State. This Company failed in 1860, and I went home in the spring.

"In December, 1860, went to Cuba and engaged on the Ferro Carril del Oeste, under Chief Julio Lagbien, as Asst. Chief. Road extended from Havana to Pinar del Rio, western portion of the island. Returned to Vermont in April, 1861.

"Was married in Albany, New York (Brother Clark being present); afterward went back west and became assistant to the Chief Engineer, W. R. Sill, of the La Crosse and Milwaukee until 1863. Soon the Chicago, Milwaukee and St. Paul was organized, when I was appointed Chief Engineer; the first President being Alexander Mitchell. Held this position forty-six years, Russell Sage, Vice-President part of the term. Second President, Roswell Miller; third President, A. J. Earling.

"I conducted examinations through all the passes through the Rocky Mountains. About three hundred men, forty engineers. My present work—extension of the line to the Pacific Coast—the most important of all.

"On the St. Paul Road, east of Butte, Montana, are one hundred and seven miles of bridges, twelve tunnels, the longest one and one-half miles. My part of the work extends from the Missouri River to Butte, Montana, under the name of the Chicago, Milwaukee and Puget Sound Railroad. I now have charge of about nine thousand miles of railroad.

"In 1884 was chosen President of the American Society of Civil Engineers.

"In 1889 went to England to attend C. E. Convention as Past-President. Convention was held in London in Guildhall, a place where no other association had held exercises for two hundred years. Responded to the toast: 'The Civil Engineers'. Met Tyndall,* the scientist, and many other notables, among whom was Sir William Armstrong, inventor of the Armstrong gun.

"After the convention, traveled with my wife, son Eugene, and daughter Fannie, through Switzerland, Germany, Brussels, France, and England.

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* Note by Mr. Whittemore's brother: "A pleasant feature of the first trip abroad was the meeting with Professor Tyndall. He gave Don an invitation to bring his family to a luncheon at his home, which was served in a small room or hut among the heather, which he and his wife occupied while building their house. Opposite was Mrs. Humphrey Ward, also near by was Tennyson's home. When they arrived he greeted them very cordially, even throwing his arms about Don, saying, 'This is my friend Whittemore.'—A. G. W."

"Second trip abroad was made in 1903 with my wife and niece Regia, and visited Italy, Switzerland, France, and England.

"On the 50th year of service on the St. Paul Railroad, to commemorate the event, I was, by order of the President, given a private car trip to Mexico and California with everything furnished, to which I invited my wife, and my brother's wife, son, and daughter. A very enjoyable trip without serious accident." "D. J. W."

For about fifty years Mr. Whittemore resided in Milwaukee, Wis., and in a "History of Milwaukee from its First Settlement to the Year 1895" there is found an account of his work and personality, written about 1896, as follows:

"Don J. Whittemore.—In Volume XXI of the *Transactions* of the American Society of Civil Engineers, published some years since, Mr. Whittemore introduced the discussion of an important subject with this unique and strikingly original utterance: 'The Scrap Heap—that inarticulate witness of our blunders, and the sepulchre of our blasted hopes; the best, but most humiliating legacy we are forced to leave to our successors—has always, to me, been brimful of instruction.' The keen analysis of man's mental processes can hardly fail to discover in this utterance of one of the most famous of living civil engineers one of the secrets of his success. While looking forward he has not forgotten to look backward. While planning for the future he has not been unmindful of the past. Delving into the 'scrap heap', he has uncovered mistakes to avoid the repetition of them, has brought to light blunders which he caused to be set up as guide boards pointing out the way not to go thereafter, and has garnered gems of wisdom to crown future efforts. Out of the ashes of failure he has evolved the phœnix of success, and, in overhauling the débris of the scrap heap, it has been a matter of little consequence to him whether the errors exposed to view have been his own or those of some one else, so long as experience had demonstrated that they were errors. Blind dogmatism has had no place in his philosophy, and progress has been the rule of his life.

"To write of Don J. Whittemore all that might properly be written of him in this connection, would be to write an important chapter in the history of western railway construction and development. But the present purpose of the writer is rather to deal with the personality of the man who has attained a celebrity unequalled by that of any other man identified in a similar capacity with western railway enterprises.

"Born in Milton, Vt., December 6th, 1830, Mr. Whittemore is a descendant, seven generations removed, of Thomas Whittemore, who was one of the earliest settlers of Charlestown, Mass. Thomas Whittemore came to this country from Hitchin, an ancient market town in Hertfordshire, near London, about the year 1640, and settled in that part of Malden which is now Everett, Mass. In 1645 he was the owner of a farm on the western border of Chelsea, which remained in the possession of his descendants until 1845, a period of two hundred years. Albert Gallatin Whittemore married Abby Clark, also of English ancestry, and Don J. Whittemore was the second son born of this union. The elder Whittemore was a noted lawyer of Milton, Vt., participated as a volunteer in the battle of Plattsburg in 1814, was distinguished locally as a fluent and impressive public speaker and linguist, and a thorough mathematician. The son received his early education under the preceptorship of his father, in whom he had a most competent teacher, and later attended for a time Bakersfield Academy. Leaving school when he was seventeen years of age, he became connected with the engineering corps of the Vermont and Canada Railroad Company, and his proficiency in the science of civil engineering, even at that early age, is attested by the fact that when he was nineteen years old he was appointed Assistant Engineer of this company, having charge of construction of the line between Swanton, Vt., and Rouse's Point, N. Y. Having completed this work, he was appointed Assistant Engineer and placed in charge of construction of a division of the Great Western Railway of Canada. He retained that position until 1852, when the sudden death of his father brought about a change of his relations. The elder Whittemore was at that time largely interested in the building of the Central Ohio Railway, between Zanesville, Ohio, and Wheeling, Va. He was accidentally killed while inspecting the superstructure of a bridge across the Muskingum River at Zanesville, and the responsibility of looking after his interests devolved upon the son, who happened to be paying him a visit at the time of his death. Resigning his position with the Great Western Railway Company, D. J. Whittemore became contractor's engineer on the Central Ohio Railroad, and retained that position while giving attention to the adjustment of his father's affairs.

"In this way he became interested in what was looked upon in those days as Western railway building, and in 1853 was transferred to the field of his future activity and enterprise in the Northwest. He was appointed that year assistant to the Chief Engineer of the La Crosse and Milwaukee Railroad Company, then in process of construction. At the end of four years in this service he resigned his position with the La Crosse and Milwaukee Road to become Chief Engineer and Director of the Southern Minnesota Railroad Company, locating about two hundred and fifty miles of that Company's line within the next two years. In 1859 work upon that line of railway was suspended, and, broken in health by the hardships which he had endured in traversing a country then in a condition of primitive wilderness, Mr. Whittemore went to Cuba, where he accepted the position of Assistant Chief Engineer on the Ferro Carril del Oeste (Western Railroad of Cuba) with which he was connected nearly a year.

"Returning to Wisconsin in 1860, he again became Assistant Chief Engineer of the La Crosse and Milwaukee Railroad Company, continuing his connection with that company until 1864, when its line was merged into the Chicago, Milwaukee and St. Paul Railway System. With this great corporation, which now owns and operates over six thousand miles of railway, he entered upon a term of service, as Chief Engineer, which has extended over a period of forty years, during which time the company has developed one of the great railway systems of the world.

"In the midst of his exacting railway duties he has found time not only for general scientific research, but for special pursuits which have led up to important developments.

"In 1874, or possibly a little before that time, his attention was called to the hydraulic features of the rock deposits underlying a portion of this city [Milwaukee]. He began a series of experiments which developed the fact that a first-class hydraulic cement could be made from the rock. The result was the formation of the Milwaukee Hydraulic Cement Company, in which he became interested as a shareholder, and the establishment of a plant which now sends to the market upward of 500 000 barrels of cement every year. For many years he was a director of this company, but in 1891 he resigned this directorship to become Vice-President of the Western Portland Cement Company of Yankton, S. Dak., an enterprise of which he was also one of the founders.

"In 1884 he was honored by the American Society of Civil Engineers with the Presidency of that Society, and the University of Vermont, his native State, has conferred upon him the degree of Civil Engineer; while the University of Wisconsin, his adopted State, has recognized his scientific attainments by conferring upon him the degree of Doctor of Philosophy. In the American Society of Civil Engineers he has wielded an important influence for many years, while he has also been conspicuously identified with the American Society of Mechanical Engineers, the Western Society of Engineers, and honored with a membership in the Institution of Civil Engineers of England.

"In 1889, when a delegation of about two hundred and fifty of the civil, mechanical, and mining engineers of America visited England, France, and Germany, Mr. Whittemore was made honorary chairman of the delegation, and was the recipient of distinguished honors at the hands of the engineers and scientists of the Old World. Among the pronounced scientists with whom he became intimately acquainted on that occasion was Professor Tyndall, and a friendship sprang up between the two men which resulted in a correspondence kept up until Professor Tyndall died. As Vice-Chairman of the General Committee of the World's Congress Auxiliary to the Columbia Exposition, having in charge the conduct of the World's Congress of Engineers, held at Chicago in 1893, Mr. Whittemore had an opportunity to reciprocate the courtesies extended to him some years earlier while abroad, and he was a prominent participant in the deliberations of that famous gathering of engineers. A pleasing and ready writer, he has been a frequent contributor to the published transactions of the American Society of Civil Engineers, and now and then engaged to some extent in the discussion of important engineering problems through the newspaper press."

Among Mr. Whittemore's chief characteristics was an unusually retentive memory. He has been accused of remembering the exact location of every slope stake placed by him in the early part of his career, when he was an instrument man. This, of course, is an exaggeration, but that quality of his mind is shown by the following item from the *Burlington Free Press and Times* of April 29th, 1887, printed forty years after the occurrence described:

"VERMONT AND CANADA ROAD
"Where its Construction Was First Begun—
"An Interesting Letter.

"We are permitted to copy the following from a letter written by D. J. Whittemore, Chief Engineer of the Chicago, Milwaukee and St. Paul to his brother, A. G. Whittemore, of this city.

"'I notice in Rann's history of Chittenden County, page 191, it is stated that the work of constructing the Vermont and Canada railroad was begun early in September, 1848, in the northern part of Georgia. If the author means to convey the impression that work was first begun there I feel sure that he is in error. The first ground broken in the construction of that line was at near the north end of the **Y** at Essex Junction. There were present at this ceremony Charles Paine,* President; H. R. Campbell, Chief Engineer; Phaon Jarrett, Assistant Chief Engineer; Ambrose Pierson, First Assistant Engineer; ———— Bushnell, Second Assistant Engineer; D. J. Whittemore, Rodman, and several citizens of Essex. After a few impressive remarks on the importance of the work by President Paine, he loaded one barrow with earth and wheeled it into embankment. Each of the others in the order named did the same, after which all adjourned to the office near by and drank a bottle of champagne. The shovel and wheelbarrow used were appropriately inscribed with the names of all the actors, in Capt. Jarrett's best style of lettering, and I believe were sent to Northfield and presume were burned in the conflagration which destroyed the Vermont Central buildings three years afterward. It may be that I am now the only one living who participated in this event. This is of very little importance, anyway, except to correct the impression conveyed in the work referred to.'"

In Mr. Whittemore's service of more than half a century with the Chicago, Milwaukee, and St. Paul Railway, he encountered almost every problem of railway engineering, and was able to collaborate with those who had made particular study of special problems and to learn and apply the knowledge acquired by their intensive experience, to their mutual satisfaction. This was especially the case in the matter of bridges, when, with the aid of such men as C. Shaler Smith, Moritz Lassig, Members, Am. Soc. C. E., and others, the structures over the rivers crossed by his lines were of such character as to make them noted examples of correct and bold construction. A few such bridges may be mentioned here, for the reason that they were constructed at early dates, when long-span bridges were rare, and builders were feeling their way toward present achievements. Kilbourne Bridge, over the Wisconsin River, a wooden Howe truss structure with a principal span of 242 ft., carrying a highway on its lower chords and a railway on its upper deck, served its purpose and was replaced in 1887 by an iron structure, which in turn was replaced by a steel bridge a few years ago. Moritz Lassig was the builder of the wooden bridge, C. Shaler Smith of the iron bridge, and the steel bridge was built by the Railway Company some years ago.

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* Charles Paine, President, Am. Soc. C. E., 1883.

Sabula Bridge, an iron structure over the Mississippi River, was built by C. Shaler Smith about 1879. This bridge was at that date considered one of the best examples of such construction, and it was selected by Professor Malverd A. Howe, M. Am. Soc. C. E., as an example for use in university instruction, and was made by him the subject of a textbook. This bridge was examined by experts, a few years ago, who pronounced it of excellent design and well maintained, but was recommended for replacement to provide for increased live loads from modern rolling stock. This recommendation has since been put into effect.

Minnehaha Bridge, another iron structure built by Mr. Smith, over the Mississippi River at Fort Snelling, Minn., finished in 1880, was a deck bridge, with a central span of 324 ft., two flanking spans of 270 ft. each, and some approach spans, with a height of 108 ft. from high water to base of rail. It was similar in design to Mr. Smith's cantilever bridge over the Kentucky River, which preceded it, and was considered a distinct advance in bridge construction, attracting favorable comment from bridge engineers. The Minnehaha Bridge was replaced in 1901 by a double-track steel bridge.

These bridges, though not comparable in size with the great ones of recent years, are worthy of record as advancements in the art of bridge engineering as it was thirty and more years ago. Mr. Whittemore's specifications for iron bridges, written in collaboration with the bridge engineers of those days, were classics in their line, leading the art of the time in form, completeness, and correctness of theory and design.

Mention has already been made of Mr. Whittemore's connection with a pontoon bridge at Rouse's Point in 1849-50, when he was scarcely more than a boy. It is not strange, therefore, that when, some years later, it was necessary to cross the "Father of Waters" at Prairie du Chien, he accepted the proposal of the Hon. Thomas Lawler of that city to cross both channels of the river with pontoons. For more than forty years these bridges, with large openings for navigation, have been maintained safely and economically, and have been copied at other locations.

In Mr. Whittemore's practice he had great experience with general railway contractors, and employed many of the most notable of them. Nearly all these men whose aid he secured are now dead. If they were living, material for this memoir could be gathered from them which would fill a volume of value to the Profession. He commanded the respect of such aids, and it is a notable fact that final settlements of contracts, with remarkably few exceptions, were made to the satisfaction of both parties, who accepted his rulings as just and fair. This fact, which will be appreciated by engineers of experience, was so well known that it was frequently commented on.

The diversity of work coming under his supervision was so great and the period of his office was so long that it is impossible to bring the details of it within the scope of this memoir. Mention should be made, however, of the careful and complete work which he did with his own hands. Specifications and bills of material made out in his own handwriting, which have been seen by the compilers of this memoir, are so plain and yet so complete that there is no question raised as to their exact meaning.

Mr. Whittemore was more than a railway engineer. He was a student and investigator in many lines and fields, with a rare mind capable of seeing through to the end, and he employed his facilities in his leisure moments on a multiplicity of interests. Those who were with him at such times would be surprised at the questions he would ask and at the diversity of their character, and would be instructed by his sage remarks covering a wide range of knowledge. He was on such occasions a source of instruction and an inspiration for younger men. On business trips over the lines of his company, while not in the least neglecting the work immediately in hand, he would give his assistants problems which had no immediate relation to present work but were tests of their knowledge and of their capacity for considering new questions. This seemed to be a lifetime habit in educating himself, and one having close relations with him would observe with surprise the lines of study to which he applied himself, because they were foreign to the ordinary routine of his business. He carried with him this habit of study and reflection, and friends visiting him in his quiet hours would find him absorbed in Isaac Newton's "Principia", or in some abstruse problems more or less remotely connected with those encountered in his usual practice.

He possessed an analytical mind, with a natural talent for research, and in the pursuit of knowledge he made in a quiet way valuable contributions to practical science. It was characteristic of him to be thorough in analysis and in experimentation, and always interested in the subject under consideration. Mention has already been made of his interest in the production of hydraulic cements and his successful establishment of that industry in the City of Milwaukee. This was followed by similar work resulting in the successful commercial manufacture of Portland cement at Yankton, S. Dak., at a time when Portland cements were nearly all imported and none was made west of the Alleghenies. It is not possible to place a tangible value on his work as a cement investigator, but that it was of very great value in the development of a large section of our country is evident when considered in its relation to the magnitude of the cement industry of the present time.

He gave much attention to the production of aluminum at a period antedating its manufacture on a commercial scale, and though successful in extracting it, did not reach the achievement obtained by the method at present in use.

His investigations covered a wide range of subjects, and, as might have been expected, some of his work resulted more in personal satisfaction than in practical value. An instance of this is found in the "Equilibristat" invented by him, being an instrument to be mounted in a railway car to indicate whether the super-elevation of the outer rail on curves is proper for the speed of the car passing over it. He exhibited an equilibristat and read a paper on it before the Western Society of Engineers.

Mr. Whittemore's loyalty to the railway of which he was Chief Engineer led him to consider the interest of his employer as his first and principal duty, and under that obligation he found little time to devote to personal interests outside of those pertaining to his office. Mention has been made herein of his interests in Milwaukee and Yankton cements, and a large user of both of these cements testifies that he was unable to get Mr. Whittemore to recommend either of them, even when the question was pressed for an answer. As a consequence of this policy he did not participate to any great extent in employment as a consulting engineer, and not at all without the approval of his superior officers. He might have done more of such work without detriment to his employer and to the advantage of the profession if he had not had so scrupulous a regard for his fixed obligations. His long experience, preserved by a retentive memory, with his judicial faculty of mind, was a valuable professional asset which ought to have been used more frequently for the general benefit. There were occasions when he had to yield to imperative demands for his knowledge and judgment. On two different occasions when disastrous accidents occurred to the bridge over the Missouri River at St. Charles, Mr. Whittemore was summoned to investigate and determine the causes of failure. No record has been preserved of his professional services aside from those rendered in his official position, nor of the requests for such services which he felt he ought not to accept. In 1888, he and the late Joseph M. Wilson and A. P. Boller, Members, Am. Soc. C. E., were appointed by the City of Providence, R. I., as a commission to investigate an important city problem, and much credit was given the commission for its report. In his long period of active practice there was without doubt much which could profitably be referred to in this memoir if the facts were obtainable.

Mr. Whittemore was a clear thinker, with facility for expression as a writer and speaker. With a modest man, as he was, such traits lie dormant until developed and brought to light by circumstances. When it became known that he was a well-informed and pleasing speaker, opportunities for speaking were so frequent that he acquired the habit of declining, and it was a rare occasion when he could be induced to make an address. He was urged by friends to write contributions to the history of engineering in America, which, with his long experience and observation, he was well qualified to do, but he would not yield to their solicitations. His habit of reticence seemed to grow upon him with advancing age, and it is much to be regretted that, when he began to lay down his routine duties, he did not contribute from his ripe experience for the benefit of those who had not acquired that which they knew he possessed. He departed this life after outliving all those with whom he worked in the "early days", and these men left mostly memories and traditions without actual records, but their work is not wholly lost, for those whom they educated will pass their knowledge on through their successors, and what they accomplished while living remains an intangible asset for those who come after them.

Mr. Whittemore was by nature more an engineer than an administrator. If his administration duties had outweighed his others, it is probable that he would not have limited his energies to the practice of engineering. He was associated with railway construction and maintenance throughout a lifetime, covering the development of railroads from almost their beginning, and, if his ambition had been in the line of railway promotion and management, it is altogether likely that he would have become associated with them as business enterprises rather than as fields for engineering effort. In other words, his work was professional instead of commercial in character. He must have had many opportunities for profitable employment as a contractor or a promoter, and it is characteristic of him that he appreciated his office of Chief Engineer and resisted temptation offered by more lucrative employment.

He understood the requirements of an engineering organization, and his ability to discern character enabled him to gather about him efficient and loyal assistants and to employ competent contractors. His relations with all such were friendly, and promoted the feeling of common interest instead of antagonism. As indicative of his character and of the esteem in which he was held by his associates, the following extracts from letters, sent to the compilers, may be properly introduced in this memoir.

From Mr. E. O. Reeder, Assistant Chief Engineer, Chicago, Milwaukee and St. Paul Railway:

"Although I served under and was very closely associated with D. J. Whittemore, as a subordinate, for the greater part of the time from early in 1875 until his retirement from active service in December, 1910, I find some difficulty in suggesting matter for his memoir.

"Few engineers, or in fact few managing or directing officials of a railway company, have a record of such a close and direct connection from the beginning, with the building up of a great railway of the magnitude of the Chicago, Milwaukee and St. Paul Railway.

"In the early 'Fifties', practically at the beginning of railway construction west of the State of Ohio, Mr. Whittemore was engaged on the surveys and construction of lines in Wisconsin, which were the nucleus of and are still a part of the C., M. & St. P. Railway System. I have heard him remark that he once surveyed a line across the site of the present heart of the City of Minneapolis and that no house or building was then there to obstruct his work.

"From these early days until his death, except for a few short intervals, he was connected with our company, and for the greater part of this period he was the head of the Engineering Department, and as such he planned, directed, and supervised the construction of some 6 000 miles of new railway now forming a part of the great system of over 10 000 miles, and he also planned and directed the many works and improvements that were undertaken in developing the system.

"He held to a marked degree the confidence of the managing officers of the company, from S. S. Merrill, who, perhaps more than any other, laid the foundation of the system, to A. J. Earling, who extended and built it up.

"Mr. Whittemore's reputation for justness and fairness as between the Railway Company and its contractors was so high that his decision as arbitrator was seldom, if ever, questioned, and because of this high estimation the Railway Company was able to contract its work to the best advantage, and few, if any, controversies resulted in lawsuits in settlement of contracts.

"Mr. Whittemore's personality, character, and high mental attainments commanded the admiration and respect of all who knew him. He possessed a strong and active mind.

"His subordinates loved and respected him, and felt complete confidence that he would be just and loyal in his treatment of them.

"To me, among his most marked characteristics, were his power of concentrating his mind on and his ability to thoroughly analyze a subject. Physically, he was not very rugged, and consequently had to depend upon observations and reports of others for his knowledge of many operations and conditions, especially as regards examinations and explorations for new lines. He had, to a remarkable degree, the faculty of getting from reports of others a more complete insight and understanding of pertinent facts and conditions than an ordinary man would get from actual observation, and of thereafter retaining these facts in mind.

"His reputation as an engineer can best be commented on by some one who has a wider knowledge of it than I have. His contemporaries and associates in the profession were of the most prominent engineers of the country and of the world, and his rank among them was high."

From Mr. A. G. Baker, Assistant Engineer, Chicago, Milwaukee and St. Paul Railway:

"I have to say that the following few lines relative to my personal estimate of Mr. Whittemore are submitted with diffidence, as the subject is difficult to handle as it deserves. Having been intimately associated with Mr. Whittemore for twenty-five of the thirty-eight years of service with the Chicago, Milwaukee and St. Paul Railway, I venture to say that it is possible for me to form a fairly true estimate of his qualities as a man and engineer.

"As a man and chief I think there were few, occupying the position that he did, who had the quality of winning the respect and loyalty of his subordinates, and, in my case, a degree of affection hard to express.

"On his part, he was loyal to his assistants who were deserving and tried to do their duty. In this respect, one of his chief characteristics was the solicitude he displayed for the comfort and safety of any one of his engineers sent on a specially hazardous undertaking in the line of reconnaissance or survey. Many instances of his thoughtful consideration along these lines occur to the writer, and others will bear witness to the same.

"Another characteristic was his absolute fairness in dealing with contractors. His instructions were explicit to all engineers on construction work to treat all contractors, from principals to sub-contractors and 'station men', with due consideration. All the leading contractors in the West with whom I have had business relations concur in the general statement that they could safely leave all matters of classification, etc., to Mr. Whittemore, feeling sure they would receive just treatment.

"As to his qualities as an engineer, it would seem superfluous for the writer to enlarge on his abilities, too well known to require endorsement from this source. However, it might not be out of place to mention one quality so often noticed, *i. e.,* his ability to grasp difficult situations relative to location of lines, from reports and examination ot maps and profiles, without having a personal knowledge of the country traversed, and to make valuable suggestions as to the betterment of conditions. This quality was also observed in matters relating to construction. This point was called to the attention of the writer more particularly during the construction of the Puget Sound Extension. Mr. Whittemore had not been able to go over the new line until the track was laid and the line was in operation. In 1910 it was the privilege of the several Engineers of Construction to accompany him in a business car over their portions of the work. While watching the line from the car he would frequently notice and call attention to places where particular difficulties occurred and were referred to him for advice and instruction; he having recognized them from his familiarity with the profile and map of such localities. His memory and 'bump of location' were extraordinary.

"In his dealings with his assistants, relative to their work, his fairness was proverbial. Where necessary, his criticisms were severe, and he seldom failed to strike at the root of faults. In conclusion, I cannot refrain from stating that Mr. Whittemore was as much a father to me as a chief during the many years I served under him, and my feelings of affection for him were strong."

Mr. Whittemore was a charming social companion—with rare humor he could entertain his friends for an evening and make it an occasion to be long remembered. He was a good story teller, and his reminiscences, based on the experiences of his early practice, were fascinating to younger engineers. His disposition was naturally a retiring one, and his friends greatly regretted that in the latter years of his life he seemed to avoid the gatherings of engineers. At the last Convention of the American Society of Civil Engineers attended by him (held in Chicago in 1910) he told a friend, who met him at the hotel designated as Convention Headquarters, that he was too old, that he did not know those whom he was to meet, and that they would not care to meet him. This friend arose to the occasion and privately repeated what he had said, with the result that he was given an ovation by those of all ages who were present and for a short time was made to feel young again. The present generation will have to disappear before personal recollections of him will cease to be expressed.

He had a kind heart, and, like many others who have that possession, he did not display it in public. Always helpful of others, his benefactions were not recorded. All his friends will remember him with warm feelings of regard and respect, and will continue to speak of him as one of the early builders of our profession.

On December 6th, 1910, Mr. Whittemore retired from the office of Chief Engineer of the Chicago, Milwaukee and St. Paul Railway Company, and did not thereafter perform any active duties, although he carried the honorable title of "Consulting Engineer" until the date of his death. He is survived by his widow and his daughter, who is the wife of Philip N. Littell, author and publisher, residing in New York.

Mr. Whittemore's interest in the advancement of his profession was shown by his active support of its societies in contributing to their transactions and in his labors on their committees. The Western Society of Engineers, in which he held membership, honored him by election as Honorary Member. He was also a Member of the Institution of Civil Engineers of Great Britain.

Mr. Whittemore was elected a Member of the American Society of Civil Engineers on July 10th, 1872, and an Honorary Member on January 6th, 1911. He served as a Director in 1881 and as President in 1884.

MAXYMILIAN LEWINSON, M. Am. Soc. C. E.*

Died September 19th, 1915.

Maxymilian Lewinson was born in Plock, Poland, on March 14th, 1855. After he was graduated from the Polytechnicum, in Zurich, Switzerland, in 1877, where he met Professor Ruleaux and others famed for their research work in various departments of science, he entered for a short time the employ of the German State Government.

About 1880, Mr. Lewinson came to New York City and met the trials of a stranger in a strange country with courage and determination, his education being his principal asset.

After a time, he became associated as Engineer with the late Leopold Eidlitz, an architect of great ability and extensive practice. In this capacity Mr. Lewinson was called on to solve many complex problems of construction, such as the rebuilding of the Assembly Chamber roof, at Albany, N. Y., and the reconstruction of Cooper Institute.

Mr. Eidlitz, although practicing architecture, was himself well grounded in the fundamentals of engineering, and created the tie leading to a close friendship with Mr. Lewinson, which continued to the time of Mr. Eidlitz's death.

Later, Mr. Lewinson practiced his profession on his own account, and, still later, he formed a partnership under the firm name of Baker and Lewinson, Architects and Engineers.

Under the administration of Albert F. D'Oench, Architect, then Superintendent of the Department of Buildings, he entered the employ of the City of New York. Up to this time (1888), so-called practical builders seemed to have met the needs of this Department, and the educated engineer had failed to find recognition. However, the wonderful development in building operations and the dawn of skeleton building construction in the City of New York created a demand for an engineer of ability, and Mr. Lewinson found himself, therefore, the first engineer of this important Department of the City's activities.

Toward the close of 1889 he severed his connection with the Department of Buildings, and entered business as an Engineer and Contractor for iron and steel work, especially as related to buildings.

In March, 1891, he formed a partnership with the writer to engage in general engineering practice and as contractors for structural work. This affiliation proved to be most happy, and the firm enjoyed a prosperous career until the dissolution of the partnership in 1903. Mr. Lewinson then organized the corporation of Lewinson and Company, Engineers and Contractors, and became its President, which position he retained until his untimely decease.

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* Memoir prepared by George A. Just, M. Am. Soc. C. E.

Mr. Lewinson was a contributor to the *Transactions* of the Society, and often took part in the discussion of papers presented at its meetings.

He became a member of the Engineers Club in 1890. He was also a member of the Museum of Natural History, a Director of the Manhattan Square Apartment Association, and for a term was Highway Commissioner of the Town of Scarsdale, Westchester Co., N. Y. The latter position he accepted as a public duty, giving freely of his experience and advice for the benefit of his fellow-townsmen, he having become a resident of Scarsdale.

Mr. Lewinson was married, but left no issue. An elder brother, Simeon Lewinson, engaged in mining operations in the West, survives him, as well as relatives residing in Europe.

Mr. Lewinson was a most lovable character. He delighted to entertain his friends, and always proved an admirable host. He was generous to a fault. To any one who applied to him for assistance it was promptly and cheerfully granted. He was a well-read man, with a broad general education, and this permitted him to discuss with intelligence and force, not only important questions in engineering, but also world politics, literature, and art. In his death, his professional and social acquaintances suffered a great loss.

Mr. Lewinson was elected a Member of the American Society of Civil Engineers on February 7th, 1894.

CLARENCE RUFUS NEHER, M. Am. Soc. C. E.*

DIED MAY 13TH, 1918.

Clarence Rufus Neher was born in Ashokan, Ulster County, N. Y., on February 27th, 1860. He was educated in the public schools at Ashokan, and at the Academy at Nassau, N. Y.

About 1881, Mr. Neher joined the Engineering Corps of the Genesee Valley Canal Railroad, at Nunda, N. Y., now the Rochester Division of the Pennsylvania Railroad. In 1884 he accepted the position of Assistant Engineer on the Washington and Ohio Railroad, in Virginia, under Robert Bell, Chief Engineer. Between 1887 and 1889 he was employed as Engineer in the Maintenance of Way Department of the Richmond and Danville Railroad, with headquarters at Greensboro, N. C. In 1889 he became Engineer in the Maintenance of Way Department of the Western New York and Pennsylvania Railroad, now the Rochester Division of the Pennsylvania Railroad, with headquarters at Rochester, N. Y. He held this position about nine years, or until 1898, and then resigned to become Resident Engineer in the New York State Engineer's Department on the Western Division, with headquarters at Rochester, N. Y.

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* Memoir prepared by Henry A. Van Alstyne, M. Am. Soc. C. E.

About 1900 Mr. Neher resigned this position and was appointed Engineer for the Donnelly Construction Company, of Buffalo, N. Y., remaining with the Company while the foundations for the Great Eastern and Dakota grain elevators, and other important work near Buffalo, were built. In 1901 he became Engineer and General Manager of the Continental Engineering and Contracting Company, of Buffalo, N. Y., and, in this capacity had charge of building the concrete foundations and floors of the grain elevator of the Board of Harbor Commissioners, at Montreal, Que., Canada, and also a large grain elevator at Fort William, Ont., Canada. He also had charge of building all the concrete structures on the Buffalo and Susquehanna Railroad, and the concrete dam across the Cumberland River at Burnside, Ky.

About 1909 Mr. Neher was made Engineer for the Atlantic, Gulf and Pacific Company and had charge of the engineering work on 12 miles of Barge Canal contracts between Smith's Basin and Whitehall, N. Y.

About 1912 Mr. Neher entered the service of the Buffalo Dredging Company, of Buffalo, N. Y., as Engineer and General Manager. While with this company he had charge of completing the large Barge Canal Dam at Hinckley, N. Y., and constructing the new double-track line of the International Railway Company, between Buffalo and Niagara Falls, N. Y. He was in the employ of this Company at the time of his death.

Mr. Neher was a very capable and energetic man, of high character and pleasing personality. He was married in 1882 to Nellie Louise Dodge, of Mount Morris, N. Y., who died in 1913, leaving two sons, Carl Clarence and Roy Herbert Neher. In February, 1917, he was married to Miss Janet Alison Carmichael, of Albany, N. Y., who survives him.

Mr. Neher was elected a Member of the American Society of Civil Engineers on June 4th, 1902.

PAPERS AND DISCUSSIONS CURRENT IN PROCEEDINGS

Final Report of the Special Committee on Concrete and Reinforced Concrete..........Dec., 1916
Discussion....Feb., Mar., Apr., May, Aug., Sept., Oct., 1917, Jan., Feb., Aug., Sept., 1918

"Cement Joints for Cast-Iron Water Mains." Clark H. Shaw..........Mar., 1917
Discussion..........May, Aug., "

Progress Report of the Special Committee to Codify Present Practice on the Bearing Value of Soils for Foundations, etc..........Aug., "
Discussion..........Nov., "

"Detention Reservoirs with Spillway Outlets as an Agency in Flood Control." H. M. Chittenden..........Sept., "
Discussion. (Closure)....Nov., Dec., 1917. Jan., Feb., May, Aug., Sept., 1918

"The Activities of the American Society of Civil Engineers During the Past Twenty-five Years." Chas. Warren Hunt..........Dec., 1917
Discussion..........Mar., 1918

Final Report of the Special Committee on Steel Columns and Struts..........Dec., 1917
Discussion..........Feb., Mar., Apr., Aug., 1918

Progress Report of the Special Committee on the Regulation of Water Rights...........Dec., 1917
Discussion..........Feb., 1918

"Verification of the Bazin Weir Formula by Hydro-Chemical Gaugings." Floyd A. Nagler..........Jan., "
Discussion..........Mar., May, Aug., "

"Determination of the Duty of Water by Analytical Experiment." W. C. Hammatt..........Feb., "
Discussion..........Apr., "

"The Economics of Steel Arch Bridges." J. A. L. Waddell..........Mar., "
Discussion..........May, Aug., Sept., "

"Construction Methods Used in Building the Lower Reservoir Dam of the Balmorhea Project." Vernon L. Sullivan..........Apr., "

"Improving Arch Action In Arch Dams." L. R. Jorgensen..........May, "
Discussion..........Aug., "

"Emergency Construction Work Due to War Conditions, With Especial Reference to the Construction Division of the Army." George W. Fuller..........May, "

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"Emergency Construction Work Due to War Conditions. With Especial Reference to the Construction Division of the Army." GEORGE W. FULLER........May, "

PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

VOL. XLIV—No. 8

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CIVIL
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PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

(INSTITUTED 1852)

VOL. XLIV—No. 8

OCTOBER, 1918

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NEW YORK 1918

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ON THE REGULATION OF WATER RIGHTS: F. H. Newell, W. C. Hoad, John H. Lewis.

TO REPORT ON STRESSES IN RAILROAD TRACK: A. N. Talbot, A. S. Baldwin, G. H. Bremner, John Brunner, W. J. Burton, Charles S. Churchill, W. C. Cushing, Robert W. Hunt, George W. Kittredge, Paul M. LaBach, C. G. E. Larsson, G. J. Ray, Albert F. Reichmann, H. R. Safford, F. E. Turneaure, J. E. Willoughby.

◆

The Reading Room of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

HEADQUARTERS OF THE SOCIETY—33 WEST THIRTY-NINTH STREET, NEW YORK.
TELEPHONE NUMBER....................4600 Vanderbilt.
CABLE ADDRESS......................"Ceas, New York."

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* Director William R. Hill died June 16th, 1918.

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AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PROCEEDINGS

This Society is not responsible for any statement made or opinion expressed in its publications.

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MINUTES OF MEETINGS

OF THE SOCIETY

September 18th, 1918.—The meeting was called to order at 8.30 P. M.; Director Frederic H. Fay in the chair; Chas. Warren Hunt, Secretary; and present, also, 147 members and guests.

Maj. Charles R. Gow, U. S. A., M. Am. Soc. C. E., Constructing Quartermaster, gave a description of the building of the Boston Army Supply Base. The formwork for the columns, etc., was described by Mr. S. Ross Berkowitz, Engineer for the General Contractor, and Mr. A. A. Cohill, Chief Engineer for the Contractors, gave an account of the difficulties met in the foundation work. Each of the speakers illustrated his remarks with lantern slides.

Mr. E. E. Jackson, of the 22d Regiment of Engineers, N. G. N. Y., addressed the meeting briefly in a plea for recruits for the regiment.

The Secretary announced the election,[*] by the Board of Direction, on September 10th, 1918, of 10 Members, 43 Associate Members, 1 Associate, and 17 Juniors, and the transfer of 11 Juniors to the grade of Associate Member.

The Secretary announced the following deaths:

William Williams Crehore, of Beaumont, Cal., elected Associate Member, April 4th, 1894; Member, September 3d, 1902; died September 13th, 1918.

Edgar Harold Annear, Capt., Engr. R. C., of Modesto, Cal., elected Associate Member, March 5th, 1912; died in service at Hoboken, N. J., August 28th, 1918.

George Corliss See, of Montgomery, Ala., elected Junior, September 3d, 1907; Associate Member, September 2d, 1914; died August 28th, 1918.

Adjourned.

October 2d, 1918.—The meeting was called to order at 8:30 P. M.; Director Alexander C. Humphreys in the chair; Chas. Warren Hunt, Secretary; and present, also, 115 members and guests.

The minutes of the meeting of September 4th, 1918, were approved as printed in *Proceedings* for September, 1918.

Corporal Oscar Mouvet, French Legionnaire, Croix de Guerre, three citations, gave a brief address on war experiences and the Fourth Liberty Loan.

T. Kennard Thomson, M. Am. Soc. C. E., addressed the meeting on the topic: "Some Present Problems of a Consulting Engineer above the Draft Age, with Suggestions as to Preparedness for Peace as well as for War", illustrating his remarks with lantern slides.

The Secretary announced the following death:

John Howe Peyton, of Nashville, Tenn., elected Member, June 1st, 1909; died September 14th, 1918.

The Chairman addressed the meeting briefly in reference to what is being done in the engineering colleges of the United States, particularly in connection with the Students' Army Training Corps.

Adjourned.

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[*] See *Proceedings*, Am. Soc. C. E., September, 1918, p. 785.

SOCIETY ITEMS OF INTEREST

COMMITTEE ON DEVELOPMENT

To the Committee on Development of the
American Society of Civil Engineers:

The resolutions creating the Committee, adopted by the Board of Direction, June 18th, 1918, are as follows:

"The development and application of the sciences in recent decades have caused profound changes in the social and industrial relationships of all peoples.

"The Engineer has been a leader in this progress.

"Sociological and economic conditions are in a state of flux and are leading to new alinements of the elements of society.

"These new conditions are affecting deeply the profession of engineering in its services to society, in its varied relationships to communities and nations, and in its internal organization.

"A broad survey of the functions and purposes of the American Society of Civil Engineers is needed in order that an intelligent and effective readjustment may be accomplished so that the Society may take its proper place in the larger sphere of influence and usefulness now opening to the Profession.

"Such a survey and readjustment can be accomplished successfully only with the aid of the membership throughout the country.

"Any steps toward changes in organization must lead to a revision of the Constitution of the Society, which has not been materially modified for many years, during which the Society has grown rapidly and has established 22 Local Associations of Members.

"The Constitution should be revised only after securing the views of the membership of the Society as to what its purposes and activities should be and as to the instrumentalities through which these purposes and activities should be carried out.

"Any changes in organization must take into account all the conditions above indicated, and also the relationship of the Ameri-

can Society of Civil Engineers to other engineering organizations and to the public.

"Therefore:

"*Resolved,* that a Committee be created to report on the purposes, field of work, scope of activity and usefulness, organization, and methods of work of the American Society of Civil Engineers, and to make recommendations concerning these matters; the Committee to consist of one member chosen by each Local Association of Members, and seven members at large appointed by the President.

"*Resolved,* that the President be instructed to select from this Committee an executive committee of not less than five nor more than nine members, and to appoint the chairman of this executive committee, who shall also be the chairman of the general committee.

"*Resolved,* that the President be instructed to prepare a precept for the general guidance of this Committee.

"*Resolved,* that this Committee be requested to present to the Board of Direction a preliminary report, not later than November 1st, 1918, so that it may be printed and distributed to the membership in advance of the Annual Meeting in January, 1919, at which meeting it will be presented for discussion."

Purpose and Scope.

It is intended that the Committee on Development shall make a survey of the fields of usefulness which are or should be open to the Society, consider what functions may properly be assumed by the Society, define its purposes, formulate policies and methods of work to be recommended, and consider the needs in organization and constitution. This means taking stock and making plans. The resolutions contemplate an examination of present-day conditions and an outlook into the future. They involve considering the changing social and industrial relations of the times and the opportunities and responsibilities which devolve upon the Society and its membership. The relations of the Society to other societies and to the profession generally are also included. The outcome of the work of the Committee may be modifications in the activities, functions, and methods of work, or in the emphasis in these matters, and possibly the addition of new ones. Naturally the resolutions assume that the views of the membership of the Society will be asked for and its aid obtained in determining what the Society's purposes and activities should be and how they may best be carried out. It is expected that the Committee will report definite recommendations in the field of its work and these recommendations may include proposals of fundamental changes which may involve amendment of the Constitution of the Society.

The Committee's Field.

It would be premature to outline the ground to be covered in the Committee's work; this may best be found by the Committee as its work progresses. It may serve a good purpose, however, and aid in starting effective deliberations more promptly if some expression is made of the possible content of the work. With this advantage in mind the following is suggested as representative of the field of the Committee's work:

1. Relations of the Society and its membership.
    - (a) The relations of the Society to its membership and to the profession of engineering.
    - (b) The relations of the Society to other engineering societies and to related organizations.
    - (c) The relations of the Society, its membership, and the members of the profession to public affairs, to the welfare of its members and the public, to the work of communities and nations, and to movements of the times related to industry and society.

2. Organization of the Society and the Profession.
    - (a) The functions of the central organization of the Society and its relation to other organizations.
    - (b) The functions of the Local Associations of members (including the membership at New York) and their relations to the Society, to other societies, and to groups of organizations.
    - (c) The organization of the engineering profession as a whole.

3. Technical activities of the Society and its possible branch organizations.
    - (a) Meetings, papers, publications and committee work.
    - (b) Activities related to engineering progress and engineering problems.
    - (c) Sections or divisions of the Society for specialized lines of work.

(d) Co-operation with specialized engineering societies and other organizations.

(e) Relations to other technical activities such as those of the proposed Standards Committee.

4. General activities of the Society and its possible branch organizations and co-operative organizations.

(a) Activities related to public affairs and public welfare.

(b) Activities related to the welfare of its members.

(c) Relations to organizations dealing with industrial and governmental problems.

5. Functions of the Society in relation to the younger members of the profession and to those in executive, contracting and other lines.

6. Miscellaneous needs of the organization.

7. Proposals for changes which will involve making amendments to the Constitution and formulating rules and methods of procedure.

These general topics, which are mostly self-explanatory, are necessarily interrelated in a variety of ways. The subject of the relations of the Society to its membership, the profession, the public, and the times involves questions of the purposes, functions, and organization of the Society. The organization topic relates to ways of managing activities and functioning with other organizations. The technical activities topic embraces means for carrying on the technical functions of a great engineering society, contributing to engineering knowledge, creating or developing new engineering policies, originating and bringing about constructive, progressive movements, and developing engineering practice and engineering influence. The general activities topic relates to the work of the Society in connection with public affairs and the welfare of the profession and of society. The functions of the Society with reference to the classes of members of the profession are bound up intimately with the topics already referred to. It will be noted that this outline of the field of work of the Committee is not in the form of a programme of work or order of procedure; the topics are too closely related to make it applicable to such uses.

Certain matters of policy which have been called to the attention of the Board of Direction have been referred to the Committee, such as the rewriting of the Code of Ethics of the Society, the suggested organization of American engineers abroad and the question of what policy the Society should take toward the adoption of standards, and doubtless other matters will be so referred. It seems probable that many members of the Society will have proposals which they will desire to present.

FORMULATION OF POLICIES AND DETERMINATION OF METHODS OF EXECUTION.

The great questions before the Committee, then, are (1) what are the functions which the American Society of Civil Engineers should assume and (2) how should they be carried out.

It goes without saying that a society should consider and determine the functions it will undertake and the working policies it will pursue. In considering these matters, it is apparent that the formulation of a proposition is a step which may aid in judging of the value of the proposal, since the mere attempt at making the statement may bring out its impracticability or its undesirability. The formulation of propositions, too, takes the mind away from indefinite generalities and to definite proposals which should have much the same significance to all readers. It will be evident, too, that some proposals must be accepted only as principles or ideals and not as working rules, and a distinction between these two classes may well be made. Definiteness of statement of course is essential in a report of a committee such as this. Doubtless the Committee will carefully consider functions and policies and their formulation.

Not less essential is the determination of the methods and ways of executing proposed functions and carrying out policies. In devising administrative plans it is well to keep in mind that organization should be left as simple and flexible as possible; elaborate or complicated organization and methods are likely to be ineffective; they are not self-propelling; and time makes changes in needs and scope of work.

In the course of its work the Committee will doubtless find it desirable to consider whether changes should not be made in the Constitution of the Society, even though, as has been found true in the past, changes in methods and new activities may be put into effect without amending the Constitution; the securing of the views of the membership of the districts on their choice for members of the Nominating Committee and the establishment of Engineering Council are examples of what has been done without modifications of the present Constitution. It seems likely, however, that the Committee will want to recommend ways in which the Constitution should be changed. Here again it is suggested that simplicity, flexibility, and breadth should be kept in mind, and that details be left for by-laws and regulations. It will be necessary to learn whether proposals for activities and methods come into conflict with the charter or conditions of incorporation of the Society. Possibly the conditions governing the incorporation may limit somewhat activities which the Committee may think desirable and possibly the Committee may conclude that modification in the articles of incorporation should be made or other steps be taken to give legal strength to their recommendations.

Co-operation with Committees of Other Societies.

Proposals have been made that the other national engineering societies appoint committees to take up similar work for those societies. In case such committees are formed it will be the duty of the Committee on Development of the American Society of Civil Engineers to co-operate with these committees on subjects of common interest. The Committee may also find it desirable to confer with representatives of local engineering societies over the country concerning the relations which the American Society of Civil Engineers and its Local Associations should bear to these local societies. It would appear that much may be accomplished through conferences with both national and local organizations.

Committee Procedure.

The Committee is so large and so widely distributed over the country that its work may best be done partly by correspondence and written discussion, partly through sub-committees, and partly at meetings of the whole Committee. To ensure that adequate progress be made at the first meeting of the Committee, it is important that preliminary work be done in advance of the meeting. This may well cover matters relating to the field of work, to the organization of the Committee, and to proposals for the Committee's consideration. At the first meeting, which will be called by the chairman, the organization and programme of work may be completed and questions formulated on which it is desired to have preliminary discussions by the Society. For the preliminary report requested for November 1st, 1918, the Committee can hardly expect to do much more than record a programme of work, propose questions on which the views of the membership are desired, and submit topics for discussion. Before the time of another meeting, which possibly may well be held at about the time of the Annual Meeting of the Society in January next, progress in the work will have been made, and it may be expected that much will be accomplished at this second meeting.

In its work the Committee will doubtless make a study of the engineering society organizations of this and other countries and of professional and scientific organizations of various kinds. Information concerning the Society and its work may be obtained from the Secretary of the Society.

The method adopted for selecting the Committee gives a wide geographical distribution and an opportunity for the representation of local views. It has the advantages of giving a channel by which discussions of the problems at meetings of the Local Associations of Members may reach the Committee, and it is hoped that the Local Associations will be helpful in the work. It will be borne in mind, of course, that the Committee is a committee of the whole Society, and it is expected that it will give careful and impartial attention to the interests of every part of the Society. The method of selection used should not be taken to mean that members of the Committee are delegates of the Local Associations of Members; and it also may be noted that the three geographical districts of the Society which do not have Local Associations of Members have much less than a proportionate representation on the Committee. Necessarily proposals for new activities and for modification of old ones must take into consideration the financial resources of the Society, and the financial side of all questions of course will receive the careful attention of the Committee. The questions before the Committee are the broad questions of policy, and personality will not enter into their discussion. With a variety of points of view and with the opportunity for wide-spread consideration of the proposals of the Committee, it may be confidently expected that the final report of the Committee will receive substantial approval from the Society.

The Board of Direction discussed the question of expense connected with the work of the Committee and informally agreed that a provision should be made. Doubtless this matter will be considered at the meeting of the Board of Direction on October 8th, 1918.

The Committee has a great opportunity to be of service to the American Society of Civil Engineers and its membership. It is hoped and believed that the work of the Committee will have significant and far-reaching results in the development of the Society and the usefulness of the profession of engineering.

Yours truly,

ARTHUR N. TALBOT,
President.

SEPTEMBER 14TH, 1918.

AMERICAN SOCIETY OF CIVIL ENGINEERS

COMMITTEE ON DEVELOPMENT

Appointed by the President.	ONWARD BATES, Chicago, Ill., *Chairman*	
	PAUL G. BROWN, New York City	
	CHARLES HANSEL, New York City	
	CLIFFORD M. HOLLAND, Brooklyn, N. Y.	
	FREDERICK C. NOBLE, New York City	
	H. R. SAFFORD, Montreal, Que., Canada	
	S. EVERETT TINKHAM, Boston, Mass.	
Appointed by the Several Associations of Members.	RICHARD L. HUMPHREY	Philadelphia Association
	J. C. RALSTON	Spokane Association
	ROBERT A. CUMMINGS	Pittsburgh Association
	GEORGE R. PUTNAM	District of Columbia Association
	BAXTER L. BROWN	St. Louis Association
	WILLIAM H. HOYT	Duluth Association
	GEORGE C. MASON	Portland, Ore., Association
	H. L. HAEHL	San Francisco Association
	GEORGE G. ANDERSON	Southern California Association
	E. B. THOMAS	Cleveland Association
	EDGAR S. NETHERCUT	Illinois Association
	W. L. DARLING	Northwestern Association
	JOHN L. HALL	Seattle Association
	ARTHUR PEW	Atlanta Association
	J. H. BRILLHART	Texas Association
	THOMAS L. WILKINSON	Colorado Association
	CHARLES J. TILDEN	Baltimore Association
	ARSÈNE PERRILLIAT	Louisiana Association
	FRANK T. DARROW	Nebraska Association
	GEORGE BUTLER	San Diego Association
	GARDNER S. WILLIAMS	Detroit Association

It is requested that suggestions concerning the work of this Committee be transmitted to some member of the Committee as promptly as possible.

Joint Council of the Engineering Societies of San Francisco

Minutes of the First Meeting, September 4th, 1918.

The first meeting of the Joint Council of the Engineering Societies of San Francisco was held at the Engineers' Club on September 4th, 1918. The meeting was the outcome of several conferences, of the Secretaries of the five societies, at which were discussed the advantages to individuals and to the societies of centralized activity and co-operation. As a result of these discussions, four representatives to a joint council meeting were selected by each of five National Societies having San Francisco sections, namely, the

American Society of Civil Engineers
American Society of Mechanical Engineers
American Institute of Electrical Engineers
American Institute of Mining Engineers
American Chemical Society.

Four of the twenty representatives were out of town on September 4th; the other sixteen were in attendance. N. A. Bowers, who had called the meeting, acted as Chairman *pro tem.*

The first action was to agree that the Joint Council should be officered by an executive committee of five. Professor C. D. Marx was then elected Chairman of the Executive Committee, and took charge of the meeting. The other four members of the Executive Committee, elected by ballot, were as follows: E. O. Shreve, E. C. Jones, E. C. Hutchinson, and N. A. Bowers.

The first business was action on the suggestion that steps be taken to interest the Governor of the State in appointing an engineer as a member of the California Railroad Commission. Expressions from the Presidents of the five sections indicated unanimous agreement on this point. The action already taken by the Civil Engineers in endeavoring to secure such appointment was reviewed, and it was decided that members of the Joint Council should urge their respective societies to act on the matter as promptly as possible, and that the Joint Council itself should collect such data as would aid in showing the Governor the desirability of such an appointment. The policy approved was to urge the appointment of an engineer, without specifying any engineer in particular. It was agreed that it was eminently proper to emphasize the need of having an engineer on commissions which regularly take up engineering questions. It was believed that the agreement on this subject of our joint membership, totaling more than 1 000 engineers, would carry weight when properly presented.

Passing to the next order of business, it was agreed that the spirit of joint meetings would be improved, and that the closer relationship desired would be fostered, by the organization of a Glee Club. Mr. Bowers was instructed to endeavor to organize such a club.

To establish a fund for current expenses of the Joint Council, it was decided that each society should advance the sum of $5. This amount was turned over to Mr. Bowers by four of the five presidents in attendance.

Mr. Jones outlined the plans of the joint meeting which the Mechanical Section purposes to hold on September 26th, 1918, and was assured of the hearty support of the four other sections.

It was decided that the Joint Council should meet for luncheon at the Engineers' Club on the second Tuesday of each month.

Adjourned.

Nathan A. Bowers,
Secretary-Treasurer.

ANNOUNCEMENTS

The Reading Room of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

FUTURE MEETINGS

November 6th and 20th, 1918.—8:30 P. M.—Meetings will be held on these evenings as usual, and announcement of the speakers and subjects will be made later.

LIST OF NOMINEES FOR THE OFFICES TO BE FILLED AT THE ANNUAL ELECTION, JANUARY 15th, 1919

The following list of nominees for the offices to be filled at the Annual Meeting, January 15th, 1919, received from the Nominating Committee, was presented to the Board of Direction at its meeting on October 8th, 1918. The list has already been mailed to all Corporate Members:

For President, to serve one year:

Fayette Samuel Curtis, Boston, Mass.

For Vice-Presidents, to serve two years:

Herbert Samuel Crocker, Denver, Colo.
Leonard Metcalf, Boston, Mass.

For Treasurer, to serve one year:

Arthur Smith Tuttle, New York City

For Directors, to serve three years:

George Hallett Clark, New York City	District No. 1
Jacob Stinman Langthorn, New York City	District No. 1
Charles Clement Elwell, New Haven, Conn.	District No. 2
Willard Beahan, Cleveland, Ohio	District No. 6
John Watson Alvord, Chicago, Ill.	District No. 8
Carl Ewald Grunsky, San Francisco, Cal.	District No. 13

SEARCHES IN THE LIBRARY

In January, 1902, the Secretary was authorized to make searches in the Library, upon request, and to charge therefor the actual cost to the Society for the extra work required. Since that time many searches have been made, and bibliographies and other information on special subjects furnished.

The resulting satisfaction to the members who have made use of the resources of the Society in this manner has been expressed frequently, and leaves little doubt that if it were generally known to engineers that such assistance could be had, many would avail themselves of it.

On October 1st, 1916, the Library of the American Society of Civil Engineers ceased to exist as such, and was merged in the Engineering Societies Library, adding 67 000 volumes to the collection, which comprises also the former libraries of the American Institute of Mining Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, and now has a total of 133 000 volumes and pamphlets. Containing, as the Library now does, the special collections mentioned, its scope is broadened, and, as it receives an unusually large number of technical periodicals, it is well equipped to continue the service formerly rendered by the Society Library.

The Engineering Societies Library offers this service at a cost which is trifling compared with the value of the time of an engineer who personally looks up such matters, and the work can be performed quite as well, and much more quickly, by persons familiar with the Library.

In asking that such work be undertaken, members should specify clearly the subject to be covered, and whether references to general books only are desired, or whether a complete bibliography, involving search through periodical literature, is desired.

It sometimes happens that references are found which are not readily accessible to the person for whom the search is made. In that case the Library is prepared to furnish photographic copies of the material at a small price per page. This method is particularly useful when there are drawings or figures in the text, which would be very expensive to reproduce by hand.

The Library is also able to provide translations of articles in foreign languages when desired.

Requests for searches, copies, translations, etc., should be addressed to the Director, Engineering Societies Library, 29 West 39th Street, New York City, who will gladly give information concerning the charges for the various kinds of service.

PAPERS AND DISCUSSIONS

Members and others who take part in the oral discussions of the papers presented are urged to revise their remarks promptly. Written communications from those who cannot attend the meetings should be sent in at the earliest possible date after the issue of a paper in *Proceedings*.

All papers accepted by the Publication Committee are classified by the Committee with respect to their availability for discussion at meetings.

Papers which, from their general nature, appear to be of a character suitable for oral discussion will be published as heretofore in *Proceedings*, and set down for presentation to a future meeting of the Society, and, on these, oral discussions, as well as written communications, will be solicited.

All papers which do not come under this heading, that is to say, those which from their mathematical, or technical nature, in the opinion of the Committee, are not adapted to oral discussion, will not be scheduled for presentation to any meeting. Such papers will be published in *Proceedings* in the same manner as those which are to be presented at meetings, but written discussions only will be requested for subsequent publication in *Proceedings* and with the paper in the volumes of *Transactions*.

The Board of Direction has adopted rules for the preparation and presentation of papers, which will be found on page 35 of the Year Book for 1918.

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association, Organized 1905.

Jerome Newman, President; Nathan A. Bowers, Secretary-Treasurer, 502 Rialto Building, San Francisco, Cal.

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet, and weekly informal luncheons. The former are held at 6 P. M., at the Palace Hotel, on the third Tuesday of February, April, June, August, October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at noon, every Wednesday, at the Engineers' Club, 57 Post Street, where special tables are reserved for members and guests of the Association.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest.

Colorado Association, Organized 1908.

L. R. Hinman, President; A. N. Miller, Secretary-Treasurer, 1400 West Colfax Avenue, Denver, Colo.

The meetings of the Colorado Association of Members of the American Society of Civil Engineers (Denver, Colo.) are held on the second Saturday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary. The meetings are usually preceded by an informal dinner. Members of the American Society of Civil Engineers will be welcomed at these meetings.

Weekly luncheons are held on Wednesday at 12.30 P. M., at Daniels and Fisher's.

Visiting members are urged to attend the meetings and luncheons.

(Abstract of Minutes of Meeting)

July 27th, 1918.—A special meeting of the Association was held at the Denver Athletic Club. Owing to the absence of the President and Vice-President of the Association, the meeting was called to order by A. N. Miller, Secretary. Present, 8 members and 17 guests.

An invitation had been extended to the members of the Colorado Society of Civil Engineers to attend the meeting, and that Society was well represented.

The meeting had been called for the purpose of ascertaining the wishes of the members of the Association relative to the Preamble and Resolutions adopted by the Board of Direction on June 18th, 1918, with a view to the selection of a member to serve on the Committee on Development.

On motion, duly seconded, Mr. A. O. Ridgway was nominated and unanimously elected as Temporary Chairman, and, after taking the chair, requested the Secretary to read the Preamble and Resolutions adopted by the Board of Direction.

The Secretary also read a letter and telegram from the Southern California Association suggesting a preliminary conference of representatives of the Western Associations, to be held at Salt Lake City, Utah, on August 6th, 1918. Owing to the small number of members present, no definite action was taken relative to the proposed conference. The sentiment of those present, however, was opposed to sending a delegate.

It was moved, seconded, and carried that President L. R. Hinman be requested to appoint the member of the Association to serve on the Committee on Development.

Mr. E. T. Howson, Western Editor of *Railway Age* and Editor of *Railway Maintenance Engineer,* addressed the meeting on "Railway Operation under Federal Control", and the subject was discussed by Mr. C. W. Comstock and a number of the railroad men present.

On motion, duly seconded, a vote of thanks was extended to Mr. Howson for his address.

Adjourned.

Atlanta Association, Organized 1912.

B. M. Hall, President; Thomas P. Branch, Secretary-Treasurer, Georgia School of Technology, Atlanta, Ga.

Baltimore Association, Organized 1914.

H. G. Perring, President; Charles J. Tilden, Secretary-Treasurer, The Johns Hopkins University, Baltimore, Md.

Cleveland Association, Organized 1914.

Harry Fuller, President; George H. Tinker, Secretary-Treasurer, 516 Columbia Building, Cleveland, Ohio.

Detroit Association, Organized 1916.

T. A. Leisen, President; Clarence W. Hubbell, Secretary, 2348 Penobscot Building, Detroit, Mich.

The regular meetings of the Association are held on the second Friday of December, April, and October, the last being the Annual Meeting.

District of Columbia Association, Organized 1916.

A. P. Davis, President; John C. Hoyt, Secretary-Treasurer, U. S. Geological Survey, Washington, D. C.

Duluth Association, Organized 1917.

W. B. Patton, President; Walter G. Zimmermann, Secretary, Wolvin Building, Duluth, Minn.

The regular meetings of the Association are held at noon on the third Monday of each month (usually at the Kitchi Gammi Club), with luncheon, followed by a short business session and the reading of papers. Visiting members of the American Society of Civil Engineers can secure from the Secretary definite information relative to the meetings, at which they will be welcomed. The Annual Meeting is held on the third Monday in May.

(Abstract of Minutes of Meetings)

August 19th, 1918.—The meeting was called to order; President W. B. Patton in the chair; Walter G. Zimmermann, Secretary; and present, also, 18 members and 3 guests.

President Patton introduced the guests, Mr. Jesse M. Smith, Past-President of the American Society of Mechanical Engineers, who spoke briefly in regard to the desirability of unification among the Engineering Profession, and Messrs. Walter G. Swart and William H. Gallagher, President and Treasurer, respectively, of the Duluth Engineers Club, who addressed the meeting relative to the proposed plans for that Club. Mr. Woodbury, Secretary of the Club, also made a few remarks on the subject.

Mr. Byron G. Best was elected a member of the Association.

The Secretary read the Preamble and Resolutions adopted by the Cleveland Association at its meeting of July 13th, 1918, relative to the merging of the proposed Joint Association Constitutional Conference into the Committee on Development of the Society.

Mr. W. A. Clark, Chairman of the Advisory Committee to the Delegate to the Committee on Development, reported that Past-President House, who had been appointed as delegate, had been unable to accept the appointment, and that Mr. W. H. Hoyt, the alternate, had been notified of his appointment and had accepted.

Mr. W. H. Darling made a brief report regarding the meeting, at Chicago, Ill., of the Committee on Nominations for officers of the Society for the coming year.

A paper by Mr. Leland Clapper, entitled "A Few Observations and Tests on Concrete", was presented by the author, and a brief discussion of the subject followed.

Adjourned.

September 16th, 1918.—The meeting was called to order; Director E. R. Lewis in the chair; C. D. Christie, acting as Secretary; and present, also, 14 members.

Mr. John Carson, Chief Engineer of the Duluth Street Railway Company, presented a paper on "Street Railway Rail Joints", which brought out an interesting discussion on the subject.

Adjourned.

Illinois Association, Organized 1916.

A. S. Baldwin, President; Edgar S. Nethercut, Secretary-Treasurer, 1735 Monadnock Blk., Chicago, Ill.

The regular meetings of the Association are held on the second Monday of March, June, September, and December, the last being the Annual Meeting. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary.

Louisiana Association, Organized 1914.

Arsene Perrilliat, President; Eugene F. Delery, Secretary, 2007 Laharpe St., New Orleans, La.

The regular meetings of the Association are held at The Cabildo, New Orleans, La., on the first Monday of January, April, July, and October.

Nebraska Association, Organized 1917.

George L. Campen, President; Homer V. Knouse, Secretary-Treasurer, 109 City Hall, Omaha, Nebr.

Regular meetings of the Association are held on the first Saturday of each month, except July and August, and at such places as may be appointed from time to time by the Executive Committee. The Annual Meeting is held in Lincoln, Nebr., on the second Friday in January.

An "Engineers' Round Table" is reserved daily for luncheons, at Courtenay's Restaurant, 17th and Douglas Streets, Omaha, to which all engineers are invited. Visiting members of the Society are especially urged to communicate with the Secretary when in the city.

Northwestern Association, Organized 1914.

P. E. Thian, President; Ralph D. Thomas, Secretary, Care, St. Anthony Falls Water Power Co. and Minneapolis Mill Co., Minneapolis, Minn.

The meetings of the Association are held bi-monthly, alternating between St. Paul and Minneapolis, on the third Friday of each month. Information as to the time and place of such meetings will be furnished on application to the Secretary.

Philadelphia Association, Organized 1913.

Henry H. Quimby, President; C. W. Thorn, Secretary, Crum Lynne, Pa.

The regular meetings of the Association are held at the Engineers' Club of Philadelphia, 1317 Spruce Street, on the first Monday in January, April, and October, the last being the Annual Meeting.

Pittsburgh Association, Organized 1917.

Richard Khuen, Jr., President; John D. Stevenson, Secretary-Treasurer, 1231 Monterey St., Pittsburgh, Pa.

The Annual Meeting of the Association is held on the first Monday in October. The time and place of other meetings are not fixed, but this information will be furnished on application to the Secretary.

Portland, Ore., Association, Organized 1913.

Philip H. Dater, President; C. P. Keyser, Secretary, 318 City Hall, Portland, Ore.

St. Louis Association, Organized 1888 (Constitution Approved by Board, 1914).

J. A. Ockerson, President; C. M. Daily, Secretary-Treasurer, 4240 Shaw Avenue, St. Louis, Mo.

The Annual Meeting of the Association for the election of officers and for the transaction of business, is held on the fourth Monday in November. Two meetings each year, for the presentation and discussion of technical papers, are held in the Auditorium of the Engineers Club of St. Louis and are open to members of the Associated Societies. Other "get-together" meetings are held regularly for dinner or luncheon on the fourth Monday of each month except July, August, and November.

San Diego Association, Organized 1915.

N. B. Kellogg, President; P. R. Watson, Secretary-Treasurer, *pro tem.*, County Engineer's Office, San Diego, Cal.

Seattle Association, Organized 1913.

A. S. Downey, President; Phil. A. Franklin, Secretary, Care, City Engineer's Office, County-City Building, Seattle, Wash.

The regular monthly meetings and luncheons of the Association are held at the Frye Hotel, 3d Avenue and Yesler Way, at 12.15 P. M., on the last Monday of each month. All members, in any grade, of the American Society of Civil Engineers are cordially invited to attend the meetings when in the vicinity.

Southern California Association, Organized 1914.

Louis C. Hill, President; H. W. Dennis, Secretary, Edison Building, Los Angeles, Cal.

The Southern California Association of Members of the American Society of Civil Engineers (Los Angeles, Cal.) holds regular bi-monthly meetings, with banquet, at Hotel Clark, on the second Wednesday of February, April, June, August, October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at 12:15 P. M., every Thursday and the place of meeting may be ascertained from the Secretary.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in Los Angeles, and any such member will be gladly welcomed as a guest at any of the meetings or luncheons.

Spokane Association, Organized 1914.

Peter Mogensen, President; Charles E. Davis, Secretary, City Engineer's Office, Spokane, Wash.

The regular meetings of the Association are held on the second Friday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary.

Visiting members are invited to attend the meetings and luncheons.

Texas Association, Organized 1913.

R. C. Gowdy, President; J. H. Brillhart, Secretary, Care, Mosher Mfg. Co., Dallas, Tex.

Utah Association, Organized 1916.

A. B. Villadsen, President, 303 Dooly Block, Salt Lake City, Utah.

The Annual Meeting of the Association is held on the first Wednesday in April. The time of other meetings is not fixed, but this information will be furnished on application to the Secretary.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcomed by the following Engineering Societies, both to the use of their Reading Rooms, and at all meetings:

American Institute of Electrical Engineers, 25 West Thirty-ninth Street, New York City.

American Institute of Mining Engineers, 25 West Thirty-ninth Street, New York City.

American Society of Mechanical Engineers, 25 West Thirty-ninth Street, New York City.

Asociación de Ingenieros y Arquitectos de Mexico, Avenida Juarez, 12, City of Mexico, Mexico.

Assoçiacão dos Engenheiros Civis Portuguezes, Lisbon, Portugal.

Australasian Institute of Mining Engineers, Melbourne, Victoria, Australia.

Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass.

Brooklyn Engineers' Club, 117 Remsen Street, Brooklyn, N. Y.

Civil Engineers' Society of St. Paul, Public Library, St. Paul, Minn.

Cleveland Engineering Society, Chamber of Commerce Building, Cleveland, Ohio.

Cleveland Institute of Engineers, Middlesbrough, England.

Dansk Ingeniorforening, Amaliegade 38, Copenhagen, Denmark.

Detroit Engineering Society, Detroit Board of Commerce Building, Detroit, Mich.

Engineering Association of Nashville, Commercial Club Building, Nashville, Tenn.

Engineering Association of New South Wales, 5 Elizabeth Street, Sydney, New South Wales, Australia.

Engineering Institute of Canada, 176 Mansfield Street, Montreal, Que., Canada.

Engineering Societies Club of Hawaii, E. F. Cykler, Secretary, Honolulu, Hawaii.

Engineers and Architects Association of Southern California, 405 Hosfield Bldg., Los Angeles, Cal.

Engineers and Architects Club of Louisville, 1412 Starks Building, Louisville, Ky.

Engineers' Club of Baltimore, 6 West Eager Street, Baltimore, Md.

Engineers' Club of Kansas City, Robert S. Beard, Secretary, Third Floor, City Hall, Kansas City, Mo.

Engineers' Club of Minneapolis, 17 South Sixth Street, Minneapolis, Minn.

Engineers' Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa.

Engineers' Club of St. Louis, 3817 Olive Street, St. Louis, Mo.

Engineers' Club of Toronto, 96 King Street, West, Toronto, Ont., Canada.

Engineers' Club of Trenton, Trent Theatre Building, 12 North Warren Street, Trenton, N. J.

Engineers' Society of Northeastern Pennsylvania, 415 Washington Avenue, Scranton, Pa.

Engineers' Society of Pennsylvania, 31 South Front Street, Harrisburg, Pa.

Engineers' Society of Western Pennsylvania, 568 Union Arcade Building, Pittsburgh, Pa.

Florida Engineering Society, J. R. Benton, Secretary, Gainesville, Fla.

Institute of Marine Engineers, The Minories, Tower Hill, London, E., England.

Institution of Civil Engineers, Great George Street, Westminster, S. W., London, England.

Institution of Engineers of the River Plate, Calle 25 de Mayo 195, Buenos Aires, Argentine Republic.

Institution of Mechanical Engineers, 11 Great George Street, London, S. W. 1, England.

Institution of Naval Architects, 5 Adelphi Terrace, London, W. C., England.

Junior Institution of Engineers, 39 Victoria Street, Westminster, S. W., London, England.

Koninklijk Instituut van Ingenieurs, The Hague, The Netherlands.

Louisiana Engineering Society, State Museum Building, Chartres and St. Ann Streets, New Orleans, La.

Memphis Engineers' Club, Memphis, Tenn.

Midland Institute of Mining, Civil and Mechanical Engineers, Sheffield, England.

Montana Society of Engineers, Butte, Mont.

North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, England.

Oregon Society of Civil Engineers, Portland, Ore.

Pacific Northwest Society of Engineers, 803 Central Building, Seattle, Wash.

Rochester Engineering Society, Rochester, N. Y.

Sociedad Colombiana de Ingenieros, Bogota, Colombia.

Sociedad de Ingenieros del Peru, Lima, Peru.

Societe des Ingenieurs Civils de France, 19 rue Blanche, Paris, France.

Society of Engineers, 17 Victoria Street, Westminster, S. W., London, England.

Southwestern Society of Engineers, C. E. Barglebaugh, Secretary, 703 First National Bank Building, El Paso, Tex.

Svenska Teknologforeningen, Brunkebergstorg 18, Stockholm, Sweden.

Tekniske Forening, Vestre Boulevard 18-1, Copenhagen, Denmark.

Vermont Society of Engineers, George A. Reed, Secretary, Montpelier, Vt.

Western Society of Engineers, 1735 Monadnock Block, Chicago, Ill.

ACCESSIONS TO THE ENGINEERING SOCIETIES LIBRARY

(From September 1st to October 1st, 1918)

DONATIONS *

The statements made in these notices are taken from the books themselves, and this Society is not responsible for them.

MODERN NAVIGATION BY SUMNER-ST. HILAIRE METHODS:

The First Published Work Devoted Exclusively to the Elucidation of This Subject, now so Generally Used in the U. S. Navy. By Frank Seymour Hastings. N. Y. & Lond., D. Appleton & Co., 1918. 16 + 84 pp., 6 x 4 in., cloth. 75 cents.

Presents the methods used in the Navy, in an elementary form. Contains the merchant marine method, the Sumner method and the Marcq St. Hilaire method. Intended as a supplement to the author's "Navigation—A Short Course".

HANDBOOK OF MECHANICAL AND ELECTRICAL COST DATA;

Giving Shipping Weights, Capacities, Outputs, and Net Prices of Machines and Apparatus, and Detailed Costs of Installation, Maintenance, Depreciation, and Operation; Together with Many Principles and Data Relating to Engineering Economics. By Halbert P. Gillette and Richard T. Dana. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1918. 17 + 1734 pp., illus., tab., 7 x 5 in., flexible cloth. $6.00.

This handbook is similar in method to the authors' two previous handbooks covering costs in the field of civil engineering and can be used to supplement them. It is almost entirely devoted to purely electrical and mechanical subjects. Chapters on general economic principles, depreciation, repairs, and renewals are included.

FRENCH-ENGLISH AND ENGLISH-FRENCH DICTIONARY OF AVIATION.

By Robert Morris Pierce. N. Y., Languages Publishing Co. (1918). 13 + 12 pp., 7 x 4 in., paper. 60 cents.

A brief bi-lingual dictionary of words and phrases, with the pronunciation carefully indicated.

CONCRETE STONE MANUFACTURE.

By Harvey Whipple. Detroit, Concrete-Cement Age Publishing Co., 1918. 318 pp., 82 illus., 104 pl., 7 x 5 in., cloth. $1.50.

A textbook for manufacturers of factory-made concrete units, based on the practice of various successful enterprises. Discusses plant layout, operation, methods, materials, finishing, building regulations, tests, etc.

THE METALLURGIST'S AND CHEMIST'S HANDBOOK:

A Reference Book of Tables and Data for the Student and Metallurgist. Compiled by Donald M. Liddell. 2d ed., revised and enlarged. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Pub. Co., Ltd., 1918. 65 pp., illus., tab., 7 x 4 in., flexible cloth. $4.00.

A collection of tables and condensed data selected to include those most necessary to the chemist and metallurgist. Additions to this edition bear chiefly on war activities, such as alloys and toxic gases. A short chapter on organic chemistry is also included.

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* Unless otherwise specified, books in this list have been donated by the publishers.

700 FRENCH TERMS FOR AMERICAN FIELD ARTILLERYMEN.

By Edward Bliss Reed. With a Foreword by Lt.-Col. Robert M. Danford. 2d edition. New Haven, Yale Univ. Press; Lond., Humphrey Milford, Oxford Univ. Press, 1918. 66 pp., cloth, 5 x 4 in. 50 cents.

A brief vest-pocket vocabulary of the French words most frequently used in field artillery.

SIR WILLIAM RAMSAY:

Memorials of His Life and Work. By Sir William A. Tilden. Lond., Macmillan & Co., Ltd., 1918. 16 + 311 pp., 4 pl., 4 por., 9 x 6 in., cloth. $4.00.

The author has written an interesting, readable account of Sir William Ramsay's career, which does justice to his scientific work and gives at the same time a pleasant picture of the man himself. He has had the advantage of Lady Ramsay's co-operation, and has made use of the letters preserved by her and other members of the family.

STUDIES ON SOLUTION IN ITS RELATION TO LIGHT ABSORPTION,

Ductivity, Viscosity, and Hydrolysis: A Report upon a Number of Experimental Investigations Carried Out in the Laboratory of the Late Professor Harry C. Jones. Compiled by Paul B. Davis. Wash., Carnegie Inst., 1918. 144 pp., 25 illus., 116 tab., 10 x 7 in., paper. $2.00.

The report represents the various lines of investigation pursued under Professor Jones' direction during 1915–16, all of which have some bearing on the conceptions of solution in general and of solution in particular, which have been developed by that laboratory.

GUIDE TO THE USE OF UNITED STATES GOVERNMENT PUBLICATIONS.

By Edith E. Clarke. Boston, The Boston Book Co., 1918. 308 pp., 9 x 6 in., cloth. $2.50.

A guide to the history, use, cataloguing, and classification of United States Government publications. Written primarily for librarians and library workers, it is broad enough in scope to serve as a laboratory manual for all who use the Government publications inside libraries and out. Contains four bibliographies dealing with different phases of the subject.

A MANUAL OF ENGINEERING DRAWING

For Students and Draftsmen. By Thomas E. French. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1918. 12 + 329 pp., 556 illus., 9 x 6 in., cloth. $2.50.

A method of instruction, based on the conception of drawing as a language, with varied forms of expression, grammar, and style. New chapters on lettering, screw threads, bolts and fastenings, and structural drawing have been added; the chapters on working drawings and architectural drawing have been enlarged, and the text generally has been revised.

REINFORCED CONCRETE CONSTRUCTION: PART I;

With Examples Worked out in Detail for All Types of Beams, Floors, and Columns. By M. T. Cantell. 2d edition. Lond., E. & F. N. Spon, Ltd.; N. Y., Spon & Chamberlain, 1918. 160 pp., 75 illus., 1 pl., 7 x 5 in., cloth. (Gift of the Author.)

The chief object in this work is to endeavor to meet the requirements of students, as well as others who have practical experience but only an elementary knowledge of mathematics and mechanics, for a simple practical treatment of the subject. Part I contains the principles, general information, and examples of designing required by the majority of students and practical men. This edition is revised to comply as far as possible with American and Canadian, as well as British, conditions and practice.

SUMMARY OF SOCIETY MEMBERSHIP SERVING IN THE ARMIES AND NAVIES OF THE UNITED STATES AND ITS ALLIES

October 9th, 1918

AMERICAN ARMY

Major-Generals	8
Brig.-Generals	14
Colonels	42
Lt.-Colonels	45
Majors	222
Captains	510
First Lieutenants	256
Second Lieutenants	76
Regimental Sergeants	1
Master Engineers	7
Master Gunners	2
Sergeants	15
Corporals	7
Privates	41
Students, Training Camps	22
Miscellaneous	6
Total	1274

BRITISH ARMY

Brig.-Generals	1
Lt.-Colonels	5
Majors	8
Captains	17
Lieutenants	17
Second Lieutenants	6
Corporals	1
Privates	1
Miscellaneous	1
Total	57

FRENCH ARMY

Commandant (rank not given)	1
Captains	2
Sous-Lieutenant	1
Aspirant	1
Miscellaneous	2
Total	7

ITALIAN ARMY

Colonel	1
Total in Armies	1339

SUMMARY FOR ARMIES

Major-Generals	8
Brig.-Generals	15
Colonels	43
Lt.-Colonels	50
Majors	230
Commandant (rank not given)	1
Captains	529
Lieutenants	273
Second Lieutenants	83
Regimental Sergeants	1
Master Engineers	7
Master Gunners	2
Sergeants	15
Corporals	8
Privates	42
Students, Training Camps	23
Miscellaneous	9
Total	1339

AMERICAN NAVY

Rear-Admirals	4
Captains	4
Commanders	9
Lt.-Commanders	15
Civil Engineers (rank not given)	14
Lieutenants	23
Lieutenants (Junior Grade)	11
Ensigns	10
Asst. Paymaster (rank not given)	1
Chf. Machinist's Mate	1
Chf. Carpenter's Mate	1
Marine	1
Miscellaneous	1
Total	95

BRITISH NAVY

Lieutenant	1
Total in Navies	96

SUMMARY FOR NAVIES

Rear-Admirals	4
Captains	4
Commanders	9
Lt.-Commanders	15
Civil Engineers (rank not given)	14
Lieutenants	24
Lieutenants (Junior Grade)	11
Ensigns	10
Asst. Paymaster (rank not given)	1
Chf. Machinist's Mate	1
Chf. Carpenter's Mate	1
Marine	1
Miscellaneous	1
Total	96

RECAPITULATION

Total in Army	1339	
Total in Navy	96	
Total on Roll of Honor		1435
Died in Service		7
Grand Total		1442

ROLL OF HONOR

A List of Members of the Society Who are Serving in the Army or Navy of the United States or Any of Its Allies.*

VANSITTART, GEORGE EDWARD. *Maj., 13th Battery, Canadian Field Artillery, 2d Canadian Div.; wounded in action (France); died May 14th, 1916.*

AGNEW, AUGUSTUS WATEROUS. *Capt., 3d Canadian Pioneers; wounded in action (France); died September 17th, 1916.*

HAGUE, WILLIAM. *1st Lieut., Engr. R. C., 116th Engrs.; died in service (France), January 1st, 1918.*

GOODFELLOW, JAMES GORDON. *Maj., Royal Engrs.; killed in action (France), March 23d, 1918.*

BUCKWALTER, DANIEL HARRIS. *Capt., Engr. R. C.; killed in action (France), May 12th, 1918.*

LINDBERY, CHARLES ARTHUR. *Capt., Engr. R. C.; died in service (Camp Lee, Va.), May 27th, 1918.*

ANNEAR, EDGAR HAROLD. *Capt., Engr. R. C.; died in service (Hoboken, N. J.), August 28th, 1918.*

Abbot, Frederic V. Brig.-Gen., Engineers, U. S. A.

Abbot, Frederick William. Lt.-Col., British Army.

Acher, A. H. Maj., Engineers, U. S. A.; Acting Lt.-Col., 4th Engrs., A. E. F., France.

Acker, Robert L. Corporal, Headquarters Co., 7th F. A., A. E. F., France.

Ackerman, Alexander S. Capt., Engineers, U. S. A., A. E. F., France.

Ackerman, Arthur P. 1st Lieut., Engineers, U. S. A., 517th Engrs.

Adams, Arthur. Maj., Ordnance, U. S. A.

Adams, Edward M. Maj., U. S. A.

Adams, Milton Jewell. Capt., Engineers, U. S. A., Co. C, 114th Engrs.

Adams, Raymond E. Capt., Quartermaster Corps, U. S. A.

Adams, Walter Francis. Sergeant, 23d Engrs., A. E. F., France.

Adams, William H. Capt., Quartermaster Corps, U. S. A.

Albert, Frederick W. Lt.-Col., Engineers, U. S. A., 33d Engrs.

Alden, Herbert C. 1st Lieut., Coast Artillery, U. S. A.

Alden, Langford Taylor. Aspirant, 7^{e} Batterie, 51st Regt. d'Artillerie, Secteur Postal No. 82 (French Army); Care, Morgan, Harjes Cie., Boulevard Haussmann, Paris, France.

Alderman, Ernest S. 2d Lieut., Quartermaster Corps, U. S. A.

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* This list is made up from replies to a circular forwarded to members of the Society, and others, and is probably neither accurate nor complete. It is requested that the attention of the Secretary be called to any omissions or inaccuracies in order that they may be corrected in subsequent lists.

Alexander, E. Porter. 1st Lieut., Engineers, U. S. A., 509th Engrs., A. P. O. 701, A. E. F., France.

Alexander, Kay. Maj., 2d in Command, 12th Canadian Ry. Troops, B. E. F., France.

Allen, Franklin R. Capt., Engineers, U. S. A.

Allen, Herschel Heathcote. Capt., Engineers, U. S. A.

Allen, Ralph B. 1st Lieut., Engineers, U S. A., Co. B, 25th Engrs., A. E. F., France.

Allen, Walter Henry. Maj., Engineers, U. S. A.

Allen, Walter Hinds. Civ. Engr. U. S. N. (rank of Lt.-Commander).

Allison, L. M. 2d Lieut., Infantry, U. S. A.

Allison, William F. Maj., Engineers, U. S. A., A. E. F., France.

Altman, Frank S. Lieut., Engineers, U. S. A., 23d Engrs.

Altstaetter, F. W. Col., Engineers, U. S. A.

Anders, Frank L. Capt., Quartermaster Corps, U. S. A.

Anderson, J. E. Maj., 212th Field Co., Royal Engrs., B. E. F., France.

Anderson, J. H. Capt., Engineers, U. S. A.; Adjt., 1st Replacement Engrs.

Anderson, W. P. Capt., Engineers, U. S. A., A. E. F., France.

Anderson, W. S. Cadet, School of Military Aeronautics, U. S. A.

Andrew, Clarence R. Capt., Engineers, U. S. A., 32d Engrs.

Andrews, Carl B. Capt., Engineers, U. S. A.

Andrews, J. H. M. Maj., Ordnance, U. S. A.

Angas, Robert M. 1st Lieut., U. S. A., 106th Engrs.

Applegarth, Gault. Capt., Engineers, U. S. A., 23d Engrs.

Ardery, Edward Dahl. Col., Engineers, U. S. A.; Chf. Gas Officer, 2d Army Corps, A. E. F., France.

Armitage, George W. Capt., Quartermaster Corps, U. S. A.

Arms, Leo M. Lieut., Engineers, U. S. A., Co. F, 2d Engrs., A. E. F., France.

Armstrong, Charles Johnstone. Brig.-Gen.; Chf. Engr., H. Q., Canadian Army Corps, B. E. F., France.

Armstrong, Harry A. 6th Co., E. O. T. C., Camp A. A. Humphreys, Va.

Armstrong, Merwin. Capt., Engineers, U. S. A., Co. D, 105th Engrs., A. E. F., France.

Arn, William G. Maj., Engineers, U. S. A., 13th U. S. Engrs. (Ry.), Postal Sector 215, A. E. F., France.

Ashkins, Nathan Thomas. 1st Lieut., Engineers, U. S. A., Lines of Communication, Eng. Headquarters, A. E. F., France.

Ashley, Carl. Capt., Engineers, U. S. A., U. S. Military P. O. 702, A. E. F., France.

Ashmead, P. H. Maj., Engineers, U. S. A.

Ashton, Raymond. 2d Lieut., Air Service, U. S. A., A. E. F., France.

Asplundh, E. T. Capt., Engineers, U. S. A.; Supply Officer, 103d Engrs.

Asserson, Henry Raymond. Maj., Engineers, U. S. A., C. E. L. O. C., A. E. F., France.

Atterbury, W. W. Brig.-Gen.; Director-General of Transportation, A. E. F., France.

Atwood, William G. Lt.-Col., Engineers, U. S. A., 17th Engrs. (Ry.), U. S. A. P. O. 701, A. E. F., St. Nazaire, France.

Austill, Hurieosco. Capt., Engineers, U. S. A., Co. D, 501st Engrs. (Service Bn.), A. E. F., France.

Austin, H. A. R. 1st Lieut., Engineers, U. S. A.

Ayres, John Henry. Capt., Engineers, U. S. A., Co. D, 42d Engrs.

Ayres, Quincy C. 2d Lieut., Engineers, U. S. A. (*Unattached*), A. E. F., France.

Babbitt, Harold E. Capt., Engineers, U. S. A., U. S. P. O. No. 757, A. E. F., France.

Baffrey, Charles R. Capt., 102d Reg. d'Artillerie (French Army), Secteur Postal 160, B. C. M., Paris, France.

Bailey, Lewis P. Capt., Engineers, U. S. A., Co. A, 304th Engrs.

Bakenhus, R. E. Civ. Engr., U. S. N. (rank of Commander).

Baker, George L. 1st Lieut., Infantry, U. S. A.

Baker, H. S. Lt.-Col., Engineers, U. S. A., 111th Engrs.

Baker, Shirley. Capt., Engineers, U. S. A., Co. B, 23d Engrs.

Balch, William H. Capt., Engineers, U. S. A., A. P. O. 712, A. E. F., France.

Barber, Charles W. Private, 38th U. S. Engrs.

Barber, Justin F. Sergeant, Co. M, 23d Engrs., A. E. F., France.

Barber, Norman N. Capt., Engineers, U. S. A., 16th Engrs., A. E. F., France.

Barclay, A. J. 1st Lieut., Engineers, U. S. A.

Barnard, Archer F. 1st Lieut., Engineers, U. S. A. (*Unassigned*).

Barney, Samuel E. Maj., Engineers, U. S. A. (*Unassigned*).

Bartholomew, B. W. Lieut., Engineers, U. S. A., 301st Engrs.

Bascom, George R. Maj., Sanitary Corps, U. S. A.

Bassett, Herbert H. Maj., Engineers, U. S. A.

Battie, H. S. 1st Lieut., Engineers, U. S. A.

Baxter, O. G. Capt., Engineers, U. S. A., Co. C, 601st Engrs.

Bayliss, Paul. 2d Lieut., Engineers, U. S. A., 8th Engrs. (Mounted).

Beach, Lansing H. Col., Engineers, U. S. A.

Beale, Allan S. Lieut., U. S. Air Service (Aeronautics).

Beall, Pendleton. Private, Headquarters Co., 165th Inf., A. E. F., France.

Beam, Carl Eugene. 2d Lieut., Engineers, U. S. A.

Bebb, Edward C. Capt., Engineers, U. S. A.

Beeman, Thomas R. Capt., Engineers, U. S. A., Care, D. G. T., A. E. F., France.

Beerbower, Dumont. Capt., Engineers, U. S. A., Co. C, 535th Engrs.

Begg, R. B. H. Capt., Engineers, U. S. A., A. E. F., France.

Behrman, I. E. 1st Lieut., Engineers, U. S. A., Care, C. E. O., Zone of the Advance, A. E. F., France.

Belknap, Francis W. U. S. Army P. O. 705, A. E. F., France.

Bell, George Edward. Lieut., Canadian Engrs., Care, Bank of Montreal, Waterloo Pl., London, S. W., 1, England.

Bell, Harry W. Capt., Engineers, U. S. A., 5th Bn., 22d Engrs., A. E. F., France.

Bellinger, L. F. Civ. Engr., U. S. N. (rank of Commander).

Benham, Claude Gilbert. Capt., Coast Artillery, U. S. A.

Benham, W. L. Maj., Quartermaster Corps, U. S. A.

Bennett, John W. F. Maj., Quartermaster Corps, U. S. A.

Bennison, Ernest William. 1st Lieut., Engineers, U. S. A., 23d Engrs.

Bensel, J. A. Maj., Engineers, U. S. A.

Benson, Orville. Maj., Engineers, U. S. A., A. E. F., France.

Berdeau, Ray W. Capt., Engineers, U. S. A.; Acting Commander, 2d Bn., 220th Engrs.

Bergan, Thomas B. Lieut., U. S. A.

Betts, Clifford A. 1st Lieut., Coast Artillery, U. S. A., Battery E, 52d Artillery, A. E. F., France.

Biddle, John. Maj.-Gen., U. S. A.

Billings, A. W. K. Lt.-Commander, Civ. Engr. Corps, U. S. Naval Forces (Aviation), London, England.

Billings, Fred M. Capt., Engineers, U. S. A.

Binckley, George Sydney. Maj., Engineers, U. S. A., 112th Engrs.

Binger, Walter D. 2d Lieut., Signal Corps, U. S. A.

Birdseye, Claude H. Maj., Engineers, U. S. A., Office, Chf. of Artillery, A. P. O. 706, A. E. F., France.

Bishop, Roy P. 2d Lieut., Engineers, U. S. A., 35th Engrs., A. P. O. 735, A. E. F., France.

Bither, T. A. 2d Lieut., Signal Corps, Aviation Section, U. S. A.

Bixby, William H. Brig.-Gen., U. S. A. (*Retired*).

Black, Dudley F. Capt., Engineers, U. S. A., Co. C, 513th Engrs., A. E. F., France.

Black, G. G. Capt., Engineers, U. S. A.; Acting Adjt., 314th Engrs.

Black, James B. 1st Lieut., Engineers, U. S. A., Chf. Engr.'s Office, Headquarters, A. E. F., France.

Black, Ralph P. 1st Lieut., Engineers, U. S. A., 32d Engrs.

Black, Roger Derby. Lt.-Col., Engineers, U. S. A., Headquarters, A. E. F., France.

Black, Walter G. 1st Lieut., Co. 7, E. O. T. S., Camp A. A. Humphreys, Va.

Black, William M. Maj.-Gen., U. S. A.; Chf. of Engrs., U. S. A.

Blackman, J. W. B. Lieut., Canadian Ry. Troops, C. E. F., France.

Blair, Alexander. 2d Lieut., Royal Engrs., B. E. F., France.

Blair, McCrea Parker. Capt., No. 1 Depot Bn., Manitoba Regt., Winnipeg, Man., Canada.

Blanchard, Murray. Maj., Engineers, U. S. A., 520th Engrs.

Boesch, Clarence E. Capt., U. S. A., Co. B, 105th Engrs.

Boggs, F. C. Col., U. S. A., 315th Engrs.

Boland, Charles J. 1st Lieut., Signal Corps, U. S. A., 80th Aero Squadron, A. E. F., France.

Bolin, Harry W. Sergeant, Co. E, 23d Engrs.

Bolton, Frank L. Capt., Engineers, U. S. A.

Bond, P. S. Col., U. S. A., 107th Engrs.; Div. Engr., 32d Div., Army Engr. School, U. S. P. O. 714, A. E. F., France.

Bonner, John P. Capt., Coast Artillery, U. S. A., A. E. F., France.

Boorman, Kitchell M. Lieut., Signal Corps, U. S. A., 481st Aero Squadron, A. E. F., France.

Booth, Raymond. 1st Lieut., Engineers, U. S. A., 54th Engrs.

Booz, Horace Corey. Col., Railroad Transportation Corps, U. S. A., Care, D. G. T., A. E. F., France.

Borden, Guy. Co. 2, E. O. T. C., Camp Humphreys, Va.

Boschke, Guy. Maj., Engineers, U. S. A., M. P. O. 705, A. E. F., France.

Bott, C. N. 1st Lieut., Engineers, U. S. A., 312th Engrs.

Boult, Charles N. 2d Lieut., 28th Reinforcements, New Zealand Engrs., N. Z. E. F., Care, P. O., Wellington, New Zealand.

Bowen, Charles K. Capt., Engineers, U. S. A.

Bowen, Edward Withers. Capt., Infantry, U. S. A., 2d Inf. Replacement Regt.

Bowie, William. Maj., Engineers, U. S. A.

Bowlby, Henry L. Maj., U. S. A., 43d Engrs.

Bowles, James T.=B. Maj., Sanitary Corps, U. S. A.

Bowne, Sidney B. 2d Lieut., U. S. Public Health Service.

Boyd, George R. Capt., Engineers, U. S. A., A. E. F., France.

Boyden, Harry C. Maj., Engineers, U. S. A.

Boyle, James M. Maj., Ordnance, U. S. A.

Bragg, Kendal B. Asst. Civ. Engr. (rank of Lieut. (Junior Grade)).

Braly, Raymond F. 1st Lieut., Engineers, U. S. A.

Braunworth, Percy L. Capt., Engineers, U. S. A., Care, Director-General of Transportation, Army P. O. 705, A. E. F., France.

Bres, Edward Sedley. 1st Lieut., Engineers, U. S. A., 114th Engrs.

Brewster, Henry B. Capt., Engineers, U. S. A., and Adjt., 303d Engrs.

Breymann, John B., Jr. 2d Lieut., Coast Artillery, U. S. A., 22d Co.

Briggs, Robert W. 2d Lieut., Signal Corps, Aviation Section, U. S. A., 73d Aero Constr. Squadron.

Bright, Graham B. Capt., Engineers, U. S. A., and Regimental Adjt., 305th Engrs. (Pioneers).

Brinkley, Milo H. Capt., Engineers, U. S. A.

Bronson, Howard F. Capt., Sanitary Corps, U. S. A.

Brook, A. E. Capt., Royal Engrs., B. E. F., France.

Brooking, J. H. Capt., Engineers, U. S. A., Co. B, 12th Engrs. (Ry.), A. E. F., France.

Brooks, Josiah R. 1st Lieut., Engineers, U. S. A.

Brown, Charles E. Capt., Engineers, U. S. A.

Brown, Clarence C. 1st Lieut., Co. E, 12th Engrs. (Ry.), A. E. F., France.

Brown, Earl I. Col., U. S. A., 317th Engrs.

Brown, Elbert C. Capt., Engineers, U. S. A.

Brown, Elliot C. Lt.-Commander, U. S. N. R.

Brown, H. Whittemore. 2d Lieut., Engineers, U. S. A., A. E. F., France.

Brown, Harry Madara. 1st Lieut., Infantry, U. S. A. (*Unassigned*).

Brown, Levant R. Capt., Engineers, U. S. A.

Brown, Marshall W. Maj., Engineers, U. S. A., P. O. 702, A. E. F., France.

Brown, Norman F. Maj., Railroad Transportation Corps, U. S. A., Care, Director-Gen. of Transportation, A. E. F., France.

Brown, Robert H. Maj., Sanitary Corps, U. S. A.; San. Officer, Camp A. A. Humphreys, Va.

Brownell, E. H. Civ. Engr., U. S. N. (rank of Commander).

Bruner, Louis S. 1st Lieut., Engineers, U. S. A., 23d Engrs., A. E. F., France.

Brush, Carl F. Capt., Engineers, U. S. A., A. P. O. 716, A. E. F., France.

Bruton, Philip G. 2d Lieut., Constr. Div., Aviation Section, Signal Corps, U. S. A.

Bryan, Clark A. Capt., Engineers, U. S. A.

Buchanan, Warren Henderson. Chf. Machinist Mate, U. S. N. R. F.

Bucher, Harold F. Lieut., Engineers, U. S. A., 2d Engrs., A. E. F., France.

Buck, Richard S. Maj., 11th Engrs. (Ry.), A. E. F., France.

Buck, Walter Van. Capt., Engineers, U. S. A., 23d Engrs.

Bull, George M. Civ. Engr., U. S. N. R. F.

Bunker, George H. Capt., Engineers, U. S. A., 306th Engrs.

Bunker, Stephen S. Capt., Engineers, U. S. A., Co. C, 503d Service Bn., A. E. F., France.

Burd, Edward M. Capt., Coast Artillery, U. S. A.

Burdett, O. L. Capt., Engineers, U. S. A., Co. A, 25th Engrs., A. E. F., France.

Burger, Alfred A. 2d Lieut., Infantry, U. S. A., 19th Co., 2d Inf. Replacement Regt.

Burgess, Harry. Col., U. S. A., 16th Engrs. (Ry.), A. E. F., France.

Burkett, Joseph M. Capt., Engineers, U. S. A., A. E. F., France.

Burky, C. R. Capt., Signal Corps, Aviation Section, U. S. A.

Burr, Edward. Col., Engineers, U. S. A., Manila, Philippine Islands.

Burrell, Glenn S. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Burrowes, H. G. 1st Lieut., Engineers, U. S. A., Co. B, 25th Engrs., A. E. F., France.

Burt, Henry J. Maj., Quartermaster Corps, U. S. A.

Burton, William. 1st Lieut., Engineers, U. S. A.

Bush, Lee M. Central Officers' Training School, Camp Zachary Taylor, Ky.

Bush, Lincoln. Col., Quartermaster Corps, U. S. A.

Bushnell, Howard B. Capt., Engineers, U. S. A., A. E. F., France.

Bushnell, Howard E. Capt., Engineers, U. S. A.

Busse, Franz A. Capt., Engineers, U. S. A. (*Unattached*), A. E. F., France.

Butler, John Soule. Maj., Engineers, U. S. A.

Butler, Millard A. Col., Quartermaster Corps, U. S. A.

Butler, William P. Lieut., U. S. N. R. F

Byam, L. H. Capt., Engineers, U. S. A.

Byllesby, Henry M. Maj., Signal Corps, Aviation Section, U. S. A.

Byrd, J. H. Capt., Engineers, U. S. A., 314th Engrs.

Byrne, Thomas Sneed. Capt., Ordnance, U. S. A.

Caffall, Geoffrey A. Private, No. 1 Coy., Canadian Machine Gun Depot, Seaford, Sussex, England.

Caldwell, William H. Lieut., U. S. N. R. F.

Cameron, Harry Frank. Lt.-Col., U. S. A., 209th Engrs.

Camp, George Dashiell. 1st Lieut., Engineers, U. S. A., 316th Engrs.

Campbell, Charles C. Private, Co No. 13, Motor Group, Medical Corps, U. S. A.

Canfield, George Hathaway. Capt., Engineers, U. S. A., 316th Engrs.

Carey, Matthew L. Capt., Quartermaster Corps, U. S. A., A. E. F., France.

Carey, William N. Maj., U. S. A., 1st Bn., 313th Engrs.

Carlin, J. P. Capt., Engineers, U. S. A.

Carlson, Carl Alexius. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Caro, Phillip. Lieut., 2d Junior Co., No. 4 Command Depot, A. T. F., Codford, Wiltshire, England.

Carr, Dean O. Capt., E. O. T. S., Camp Humphreys, Va.

Carroll, James E. Maj., Engineers, U. S. A., 527th Engrs., A. P. O. 701, A. E. F., France.

Carter, E. Kemper. Capt., Engineers, U. S. A., Co. C, 518th Engrs.

Case, Charles A. 1st Lieut., Engineers, U. S. A., 314th Engrs.

Cate, Charles Edward. Capt., U. S. A., 45th Engrs.

Caton, John H., 3d. Capt., Engineers, U. S. A., Co. F, 33d Engrs.

Cattell, William A. Maj., Engineers, U. S. A.

Cerny, John W. Maj., Quartermaster Corps, U. S. A.

Chadwick, Maurice F. Private, 24th Tr. Bn., F. A. R. D., Camp Jackson, S. C.

Chamberlaine, Robert L. Capt., Aviation Section, Signal Corps, U. S. A.

Chambers, Frank T. Civ. Engr., U. S. N. (rank of Captain).

Chandler, William E. Master Gunner, Headquarters Co., 55th Artillery, C. A. C., A. P. O. 723, A. E. F., France.

Chapman, Mellville D. Lieut., U. S. Marine Corps.

Chapman, S. A. 1st Lieut., U. S. A., Co. C, 42d Engrs.

Chappell, Claude E. Capt., Co. 5, E. O. T. C., Camp Humphreys, Va.

Charnley, Walter. 1st Lieut., Engineers, U. S. A.

Chase, Clifford E. Capt., Engineers, U. S. A., Co. A, 4th Engrs.

Cheney, Sherwood A. Col., U. S. A., 110th Engrs., A. E. F., France.

Cherry, Alan Gordon. 1st Lieut., U. S. A., 301st Engrs.

Chevalier, Willard T. Capt., Engineers, U. S. A., Co. D, 11th Engrs. (Ry.), A. E. F., France.

Child, John T. 2d Lieut., Sanitary Corps, U. S. A.

Chipley, Dudley. Capt., Quartermaster Corps, U. S. A.

Chittenden, Albert Frederick. 1st Lieut., Engineers, U. S. A., Co. F, 18th Engrs. (Ry.), P. O. No. 705, A. E. F., France.

Christensen, George A. Capt., Quartermaster Corps, U. S. A.

Christophers, Reginald Gillon. (No. 60286), 2d Lieut., 34th Reinforcements, N. Z. E. F.

Church, Elihu C. Capt., Engineers, U. S. A., A. E. F., France.

Churchill, Percival M. Maj., Engineers, U. S. A., Headquarters, 538th Engrs.

Churchill, Robert C. Lieut., Co. D, 25th Engrs., A. E. F., France.

Claflin, William B. Capt., Engineers, U. S. A., Headquarters, 39th Div.

Claiborne, Herbert A., Jr. 2d Lieut., Signal Corps, U. S. A. (*Unassigned*).

Clark, Ernest A. Capt., Engineers, U. S. A.

Clark, Howard F. Capt., Engineers, U. S. A., A. E. F., France.

Clarke, Harry L. 1st Lieut., Engineers, U. S. A., Co. E, 28th Engrs.

Clarke, Thomas C. Lt.-Col., 110th Engrs., A. E. F., France.

Clarke, W. D. Capt., Engineers, U. S. A., 23d Engrs. (Highway), A. E. F., France.

Clayton, Thomas W. Capt., Engineers, U. S. A., A. E. F., France.

Cleckner, Frederick M. Private, Meteorological Section, Signal Corps, U. S. A.

Cleveland, Lou B. 1st Lieut., Engineers, U. S. A., Co. D, 105th Engrs.

Clinton, Delmar S. Maj., Engineers, U. S. A.

Cobb, William R. Lieut., U. S. N. N. V., U. S. S. *Frederick.*

Cochrane, Victor Hugo. Maj., Quartermaster Corps, U. S. A.

Coe, C. S. Maj., Engineers, U. S. A., 17th Engrs. (Ry.), A. P. O. 701, A. E. F., France.

Coe, David. Capt., R. E., Care, R. C. E., Communications, A. P. O., S 1, B. E. F., France.

Coe, E. K. Maj., Engineers, U. S. A., Care, C. E. O., L. of C., U. S. M. P. O. No. 702, A. E. F, France.

Cole, Howard J. Capt., Engineers, U. S. A.

Coleman, Eugene H. Capt., Engineers, U. S. A., 312th Engrs.

Colgan, R. J. Capt., 11th Engrs. (Ry.), A. E. F., France.

Collier, W. N. Capt., Engineers, U. S. A.

Collins, Earl H. Capt., Coast Artillery, U. S. A.

Collins, Merton C. 1st Lieut., Engineers, U. S. A.

Columbia, Curtis F. 1st Lieut., Coast Artillery, U. S. A., Heavy Artillery Headquarters, A. E. F., France.

Comly, Harry S. Meteorologist, Signal Corps, 32d Service Co., Meteorological Section, U. S. A.

Comly, James R. 1st Lieut., Engineers, U. S. A., 55th Engrs.

Compton, Arthur M. Lt.-Col., U. S. A., 126th F. A.

Compton, R. Keith. Maj., Engineers, U. S. A.

Conard, Clarence Knight. Maj., Ordnance, U. S. A.

Conard, R. A. Civ. Engr., U. S. N. R. F., Port au Prince, Haiti.

Connelly, Walter L. Master Engr., Senior Grade, Headquarters Detachment, 310th Engrs.

Connolly, A. H. Cadet, School of Military Aeronautics, U. S. A.

Connor, W. D. Col., U. S. A., Gen. Staff; Asst. Chf. of Staff, A. E. F., France.

Converse, Joseph B. Lieut., U. S. A., Constr. Div.

Conway, N. B. Capt., Engineers, U. S. A., 516th Engrs.

Cook, Paul D. Capt., Engineers, U. S. A., 109th Engrs.

Cooke, Frederick H. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Cooksey, R. M. Maj., Quartermaster Corps, U. S. A.

Coombs, Robert D. Maj., Ordnance, U. S. A.

Coomer, R. M. Capt., Engineers, U. S. A., Headquarters, Eng. Corps, Line of Communications, A. E. F., France.

Cooper, David R. Capt., Engineers, U. S. A., A. E. F., France.

Cooper, Hugh L. Lt.-Col., U. S. A., A. E. F., France.

Copeland, Robert Morris. 2d Lieut., Engineers, U. S. A.; Instr., 111th Engrs.

Corkran, Wilbur Sherman. Capt., Engineers, U. S. A., Co. A, 1st Engrs., A. E. F., France.

Cornell, J. W. Capt., Quartermaster Corps, U. S. A.

Cornish, Lorenzo D. Capt., Engineers, U. S. A., Co. C, 15th Engrs. (Ry.), A. E. F., France.

Corp, Henry W. 5th Co., E. O. T. S., Camp Humphreys, Va.

Cosby, Spencer. Col., Engineers, U. S. A., 5th Engrs.

Cotter, Carl Henry. Asst. Civ. Engr., U. S. N.

Covert, John F. 1st Lieut., Engineers, U. S. A.

Cowles, William Pierce. Maj., Engineers, U. S. A., 34th Engrs., A. E. F., France.

Cox, Leonard M. Civ. Engr., U. S. N. (rank of Commander).

Coy, Burgis G. Capt., Engineers, U. S. A., Co. D, 314th Engrs., A. E. F., France.

Cragin, Charles Calhoun. Maj., Engineers, U. S. A., 18th Engrs. (Ry.), P. O. Box 705, A. E. F., France.

Crandall, Carl. Flying Cadet, U. S. Air Service.

Crane, Albert Eli. 1st Lieut., Engineers, U. S. A., 6th Engrs., A. E. F., France.

Crane, Joseph S. Maj., Quartermaster Corps, U. S. A.

Crawford, Hugh W. Capt., U. S. A., Co. A, 110th Engrs.

Crawford, Ivan C. Maj., U. S. A., 115th Engrs., A. E. F., France.

Crecelius, S. F. Lt.-Col., Engineers, U. S. A., 101st Engrs., A. E. F., France.

Crocker, Herbert Samuel. Lt.-Col., Quartermaster Corps, U. S. A.

Crocker, James R. Capt., Engineers, U. S. A., Co. F, 106th Engrs.

Crooks, Clinton H. Capt., Engineers, U. S. A.

Crosby, W. W. Lt.-Col., Engineers, U. S. A.

Crowell, Francis S. Capt., Quartermaster Corps, U. S. A.

Crozier, William. Maj.-Gen., U. S. A.; Chief of Ordnance, U. S. A.

Cudebec, Albert B. Capt., Engineers, U. S. A., U. S. Military P. O. No. 702, A. E. F., France.

Culver, Arthur. Lieut., R. E., 156th Field Co., R. E., B. E. F., France.

Cunningham, John G. L. Capt., Ordnance, U. S. A.

Curfman, Lawrence E. Lt.-Col., 314th Engrs., A. E. F., France.

Curley, J. F. Maj., Ordnance, U. S. A.

Currey, J. W. 1st Lieut., Engineers, U. S. A., Co. C, 115th Engrs.

Currie, Thomas A., Jr. Private, 116th Engr. Detachment, A. P. O. 727, St. Aignan-Noyers, A. E. F., France.

Cushing, Edward B. Maj., Engineers, U. S. A., Supt., Army Transport Service, U. S. A. P. O. No. 705, A. E. F., France.

Cutler, Leon G. Capt., Coast Artillery, U. S. A., 57th Artillery, C. A. C., A. E. F., France.

Dallis, Park A. Capt., Engineers, U. S. A.; Adjt., 24th Engrs.

Daly, A. P. V. 2d Lieut., 4th Connaught Rangers; 48 Cathcart Rd., London, S. W., England.

Daly, D. A. Capt., Engineers, U. S. A., 16th Engrs., A. E. F., France.

Daly, John W. Lieut., Infantry, U. S. A.

Danforth, George Clapp. Capt., Engineers, U. S. A., 602d Engrs., A. E. F., France.

Darling, Clinton Stowell. 1st Lieut., 108th Engrs., A. E. F., France.

Darville, M. A. 2d Lieut., Engineers, U. S. A., A. E. F., France.

Davidson, George B. 2d Lieut., Engineers, U. S. A.

Davies, J. P. Capt., Ordnance, U. S. A.

Davis, Chandler. Capt., Engineers, U. S. A., 6th Engrs., A. E. F., France.

Davis, Daniel E. Capt., Quartermaster Corps, U. S. A.

Davis, Frederick A. W. 1st Lieut., U. S. A., Co. E, 102d Engrs.

Davis, John C. Capt., Coast Artillery, U. S. A.

Davis, Robert M. 1st Lieut., Engineers, U. S. A., 57th Engrs. (Inland Waterways).

Davy, J. J. 1st Lieut., U. S. A., 23d Engrs.

Day, Warren E. Capt., Engineers, U. S. A.

Dean, Bertram D. Capt., Engineers, U. S. A., Dept., C. and F., Headquarters, S. O. S., U. S. M. P. O. 717, A. E. F., France.

Dean, Stanley. Capt., Quartermaster Corps, U. S. A.

Dean, Willis J. 1st Lieut., Quartermaster Corps, U. S. A.

de Charms, Richard, Jr. 1st Lieut., Engineers, U. S. A., Co. A, 503d Engrs. (Service Bn.), A. E. F., France.

Dedicke, E. C. 2d Lieut., U. S. A.

Deiser, Norman A. 1st Lieut., Engineers, U. S. A.

De Leuw, Charles E. 1st Lieut., Engineers, U. S. A., 4th Engrs.

De Moss, Samuel. Private, School of Meteorology, Signal Corps, U. S. A.

Dennis, William F. Maj., Engineers, U. S. A. (*Unassigned*).

Dent, Elliott J. Col., Engineers, U. S. A., 26th Engrs., A. P. O. 765, A. E. F., France.

Derby, George McC. Lt.-Col., Engineers, U. S. A.

Diesem, Harry C. Capt., Engineers, U. S. A., 404th Engr. Depot Detachment.

Diffenderfer, Claude O. Capt., Engineers, U. S. A., 534th Engrs., A. E. F., France.

Dillman, George L. Maj., Engineers, U. S. A.

Dobson, Gilbert C. Capt., Engineers, U. S. A., 314th Engrs.

Dodd, Joseph H. L. 2d Lieut., B. W. I. Regt.; Burlington, St. Margaret's Bay, Jamaica.

Doebler, Valentine S. Capt., Quartermaster Corps, U. S. A.

Doeleman, H. F. Maj., Quartermaster Corps, U. S. A.

Dohm, Edward Clarence. Capt., Engineers, U. S. A.

Doten, Leonard S. Capt., Quartermaster Corps, U. S. A.

Douglass, Louis R. Capt., Quartermaster Corps, U. S. A.

Dow, Hezekiah Shailer. 2d Lieut., 492d Constr. Squadron, Air Service, A. E. F., France.

Doyle, John S. Maj., Engineers, U. S. A.

Drayton, Newbold. Corporal, Battery D, 108th F. A., 53d Art. Brigade, 28th Div.

Drew, C. D. Capt., 11th Engrs. (Ry.), A. E. F., France.

Drummond, William W. Capt., Engineers, U. S. A., Co. B, 524th Engrs., A. P. O. 747, A. E. F., France.

Drury, William F. Capt., Engineers, U. S. A.

Du Bois, George B. 1st Lieut., Engineers, U. S. A., Commanding 6th Engr. Train, 3d Div., A. E. F., France.

Dunlap, Walter H. 1st Lieut., Engineers, U. S. A., 109th Engrs.

Dunn, Beverly C. Maj., Engineers, U. S. A.

Dunshee, Bertram K. 1st Lieut., Engineers, U. S. A., 316th Engrs.

Du Pré, Wallace Duncan. Lieut., Quartermaster Corps, U. S. A., Mech. Repair Shop Unit No. 303.

Durham, Henry Welles. Maj., Engineers, U. S. A., 41st Engrs., A. E. F., France.

Durham, Leicester. Capt., Engineers, U. S. A., A. P. O. 733, A. E. F., France.

Dykeman, Conrad F. 1st Lieut., Engineers, U. S. A., 116th Engrs., P. O. 733, A. E. F., France.

Eager, V. M. Capt., Quartermaster Corps, U. S. A.

Eason, F. G. Capt., Engineers, U. S. A., 317th Engrs.

Easton, Russell B. Capt., Engineers, U. S. A.

Eckel, Edwin C. Capt., Engineers, U. S. A., Headquarters, A. E. F., France.

Eddy, Albert C. Capt., 55th Engrs., A. E. F., France.

Eddy, Harold M. Civ. Engr., U. S. N. R. F. (rank of Lieut.).

Edgerton, G. E. Lt.-Col., Engineers, U. S. A.

Edmondson, Ralph S. 1st Lieut., U. S. A., 27th Engrs. (Min.).

Edmonston, A. D. 2d Lieut., Engineers, U. S. A.

Edwards, G. G. Capt., Engineers, U. S. A., Co. F, 315th Engrs.

Elliott, J. W. Capt., Engineers, U. S. A., Co. A, 602d Engrs.

Elliott, Malcolm. Lt.-Col., Engineers, U. S. A., 309th Engrs., 84th Div., A. E. F., France.

Elliott, Percival. Private, Co. D, 33d Engrs.

Ellison, Alexander H. 1st Lieut., Engineers, U. S. A., 3d Bn., 20th Engrs. (Forestry).

Embury, Aymar, 2d. Capt., Engineers, U. S. A., Camouflage Section, A. E. F., France.

Emerson, Raffe. Ensign, Flying Corps, U. S. N. R. F.

Endicott, Mordecai T. Civ. Engr., U. S. N. (rank of Rear-Admiral).

Enger, Arthur L. Capt., Engineers, U. S. A.

Ernst, Oswald H. Maj.-Gen., U. S. A. (*Retired*).

Estes, F. E. Capt., 17th Engrs. (Ry.), A. E. F., France.

Everett, Chester McK. Capt., Sanitary Corps, U. S. A.

Everett, Ralph B. Private, Co. F, 23d Engrs., A. E. F., France.

Everham, Arthur C. Maj., Quartermaster Corps, U. S. A.

Fahy, Joseph Augustine. Capt., Engineers, U. S. A., Co. D, 518th Engrs.

Fairchild, John F. Maj., Quartermaster Corps, U. S. A., Brigade Headquarters, 1st Corps Troops.

Fairlie, John Walter. 1st Canadian Exp. Force (*Retired*).

Fairman, James Robert. Capt., Engineers, U. S. A.

Falk, Myron S. Maj., Ordnance, U. S. A.

Farley, M. M. 1st Lieut., Engineers, U. S. A.

Farrin, James M. Capt., Engineers, U. S. A.; Adjt., 6th Bn., 20th Engrs., A. E. F., France.

Fassett, Earle W. 1st Lieut., Engineers, U. S. A., 316th Engr. Train.

Feigel, John H. 1st Lieut., Engineers, U. S. A., A. E. F., France.

Feiner, Mark A. Meteorological Section, Signal Corps, Aviation Section, U. S. A.

Feltham, Percy M. Capt., Engineers, U. S. A.

Ferguson, Harry Foster. 1st Lieut., Engineers, U. S. A., O. C. E. O., Adv. Sec., L. of C., A. P. O. 714, A. E. F., France.

Fernald, Gordon H. Capt., Engineers, U. S. A., Co. D, 304th Engrs.

Fickes, Clark R. Maj., Engineers, U. S. A., A. E. F., France.

Fiebeger, G. J. Col., U. S. A., Headquarters, A. E. F

Fifer, Frank P. Capt., Engineers, U. S. A., Lines of Communications, A. E. F., France.

Finley, C. MacF. Capt., Engineers, U. S. A., 503d Service Bn., A. E. F., France.

Finnell, Woolsey. Maj., Engineers, U. S. A., 501st Engrs., U. S. A. P. O. 741, A. E. F., France

Fisher, George Joseph. 2d Co., 4th E. R. O. T. C., Camp Lee, Va.

Fisher, Janon. Maj., Engineers, U. S. A., 522d Engrs.

Fisk, Clinton H. Maj., Quartermaster Corps, U. S. A.

FitzGerald, C. C. Maj., Engineers, U. S. A., 32d Engrs.

Fitzgerald, Gerald C. 1st Lieut., Engineers, U. S. A., 319th Engrs.

Fitzpatrick, F. J. Capt., Engineers, U. S. A., Co. C, Service Bn., 508th Engrs., A. E. F., France.

Flagg, Herbert J. Capt., Coast Artillery, U. S. A.

Flagler, C. A. F. Brig.-Gen., U. S. A., 5th F. A. Brigade, A. E. F., France.

Fleming, Burton P. Capt., Engineers, U. S. A.

Flick, John K. Capt., Engineers, U. S. A.

Flook, Lyman R. 1st Lieut., Ordnance, U. S. A.

Fogerty, Merton S. 34th Prov. Squadron, Aviation Camp, Waco, Tex.

Fogg, Alden K. Asst. Civ. Engr., U. S. N. (rank of Lieut. (Junior Grade)).

Follin, James W. 1st Lieut., Sanitary Corps, U. S. A.

Fölling, B. N. Capt., Engineers, U. S. A., Co. A, 49th Engrs., A. E. F., France.

Foote, Olney N. Lieut., U. S. A., Co. G, 322d Inf.

Ford, William Ellis. Capt., Engineers, U. S. A.

Forster, Arthur Oscar. Capt., Quartermaster Corps, U. S. A.

Fortney, C. Page. Capt., Engineers, U. S. A.

Foster, Ernest H. Ensign, U. S. N. R. F.

Foster, Samuel D. 1st Lieut., U. S. A., and A. D. C., Headquarters, 53rd Artillery Brigade.

Fouilhoux, J. Andre. Capt., Field Artillery, U. S. A.

Fountain, Thomas L. Capt., Engineers, U. S. A., Care, C. O., 17th Engrs. (Ry.), U. S. A. P. O. 701, A. E. F., France.

Fowler, Charles Worthington. 1st Lieut., Signal Corps, Aviation Section, U. S. A., Commanding 485th Aero Constr. Squadron, A. E. F., France.

Fox, Henry. Capt., Engineers, U. S. A., 314th Engrs.

Fox, Stephenson W. Maj., Engineers, U. S. A.

Frank, George Stedman. Lieut., Signal Corps, Aviation Section, U. S. A., A. E. F., France.

Franklin, William H. 1st Lieut., Quartermaster Corps, Constr. Div., U. S. A.

Franks, John B. 1st Sergeant, Co. C, 353d Inf.

Freeman, William B. Capt., Engineers, U. S. A., Co. A, 509th Engrs. (Service Bn.)

French, F. C. Capt., Engineers, U. S. A., 525th Engrs.

Friedman, Harry B. Lieut., Signal Corps, Aviation Section, U. S. A.

Fries, Amos A. Col., U. S. A., 30th Engrs.; Chf. of Gas Service, A. E. F., France.

Froiseth, Richard E. 1st Lieut., Engineers, U. S. A.

Frost, Edward M. Asst. Civ. Engr., U. S. N. R. F.

Fry, Alfred Brooks. Capt., U. S. N. N. V.

Fyfe, James Lincoln. Maj., Quartermaster Corps, U. S. A.

Gabelman, Charles G. E. O. T. S., Camp Humphreys, Va.

Gailor, Chester F. Maj., Quartermaster Corps, U. S. A.

Galbreath, Albert W. 1st Lieut., Engineers, U. S. A., Co. B, 12th Engrs. (Ry.), A. E. F., France.

Gallagher, Leonard Bruce. 2d Lieut., Engineers, U. S. A., Ry. Transportation Corps, U. S. A. P. O. 717, A. E. F., France.

Galloway, John D. Maj., Engineers, U. S. A., A. E. F., France.

Galvin, James Augustine. 1st Lieut., Engineers, U. S. A.; Engr. Officer, Army General Staff Coll., U. S. Army P. O. No. 714, A. E. F., France.

Garnett, Benjamin J. 1st Lieut., Engineers, U. S. A. (*Unassigned*), A. E. F., France.

Garrett, Robert P. Capt., Ordnance, U. S. A.

Gartensteig, Charles. Capt., Engineers, U. S. A., 535th Engrs.

Gatens, Ray S. 1st Lieut., Engineers, U. S. A., Co. C, 42d Engrs., A. E. F., France.

Gausmann, Roy W. Capt., Engineers, U. S. A., Co. D, 303d Engrs.

Gayler, E. R. Civ. Engr., U. S. N. (rank of Commander), Port au Prince, Haiti.

Geib, George Albert. Capt., Engineers, U. S. A., Co. A, 527th Engrs., Service Bn.

Genung, J. H., Jr. Lieut., Engineers, U. S. A.

George, Howard H. Capt., Engineers, U. S. A., Co. E, 305th Engrs.

Getty, Lorenzo T. 1st Lieut., Signal Corps, Aviation Section, U. S. A., 75th Aero Constr. Squadron, A. E. F., France.

Gibbs, E. A. Maj., 15th U. S. Engrs. (Ry.), A. E. F., France.

Gibbs, William Wetmore. 1st Lieut., Engineers, U. S. A.

Giesen, Walter E. Private, U. S. Marine Corps, Co. 269, Bn. W.

Giesting, Frank A. Maj., Engineers, U. S. A., 302d Engrs.

Giffels, William C. 1st Lieut., Engineers, U. S. A.

Gilman, E. Dow. 1st Lieut., Engineers, U. S. A., 473d Engrs.

Gladding, James N. Capt., Engineers, U. S. A. (*Unassigned*), A. E. F., France.

Glander, John Henry, Jr. Asst. Civ. Engr., U. S. N. R. F. (rank of Ensign).

Glazier, W. L. Maj., Engineers, U. S. A.; Commanding Officer, 525th Engrs., Service Bn., A. E. F., France.

Goddard, Leslie Drew. Capt., Engineers, U. S. A.

Godfrey, Alex. H. Asst. Paymaster, U. S. N. R. F.

Godfrey, Stuart C. Lt.-Col., Engineers, U. S. A., Headquarters, 318th Engrs., A. E. F., France.

Goethals, George R. Lt.-Col., Engineers, U. S. A.

Golden, William A. Ensign, U. S. N. R. F., U. S. S. *Mary Alice.*

Goldsmith, Clarence. Maj., Quartermaster Corps, U. S. A.

Gooch, Carl Joseph. Co. E, 32d Engrs.

Goodman, Benjamin. 1st Class Private, 447th Depot Detachment, Engrs., A. E. F., France.

Goodman, Leon. Capt., U. S. A., and Adjt., 109th Engrs.

Gordon, John Blake. Care, Chf. Engr. Officer, General Headquarters, A. E. F., France.

Gordon, Samuel. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Goss, O. P. M. Capt., Signal Corps, Aviation Section, U. S. A.

Gotwals, John C. Lieut., Engineers, U. S. A.

Gough, William J. Capt., Engineers, U. S. A.

Gould, William T. Capt., Engineers, U. S. A., U. S. Military P. O. 705, A. E. F., France.

Grady, Frank L. Sergeant, Co. I, 52d Pioneer Inf.

Graff, George W. Corporal, Sanitary Corps, U. S. A.

Grant, John R. Capt. and Adjt., Royal Engrs., H. Q., R. E., 24th Div., B. E. F., France.

Grant, Kenneth C. Capt., Quartermaster Corps, U. S. A.

Grant, U. S., 3d. Col., U. S. A.

Gravell, William Henry. Capt., Engineers, U. S. A., A. E. F., France.

Graves, E. M. Maj., Engineers, U. S. A., 529th Engrs.

Gray, Earle P. 1st Lieut., Engineers, U. S. A., 16th Engrs. (Ry.), A. E. F., France.

Gray, William B. Maj., Engineers, U. S. A.

Green, Charles N. Maj., Engineers, U. S. A.

Green, Clarence Jasper. 1st Lieut., Oregon Coast Artillery.

Green, F. W. Capt., Engineers, U. S. A., 12th Engrs. (Ry.), U. S. Military P. O. 716, A. E. F., France.

Greene, F. S. Capt., U. S. A., Co. B, 302d Engrs.

Greenfield, Robert A. 303d Engrs.

Gregory, Luther E. Civ. Engr., U. S. N. (rank of Captain).

Gregory, William B. Maj., Engineers, U. S. A., A. E. F., France.

Grehan, Bernard H. 1st Lieut., U. S. A., 312th Engrs.

Griest, Maurice. 1st Lieut., Engineers, U. S. A.

Griffin, John Alden. Capt., U. S. A., Co. A, 316th Engrs.

Grigsby, Walter B. 1st Lieut., Engineers, U. S. A., 9th Engrs. (Mounted).

Grimes, James E. Capt., Quartermaster Corps, U. S. A.

Grindrod, Irvin S. 1st Lieut., Engineers, U. S. A. (*Unassigned*).

Griswold, Harry T. 2d Lieut., Coast Artillery, U. S. A.

Griswold, Hector C. Asst. Civ. Engr., U. S. N. (rank of Lieut. (Junior Grade)).

Griswold, Lee S. Capt., Engineers, U. S. A. (*Unassigned*).

Grodske, Walter J. Capt., Engineers, U. S. A.

Gross, Frederick H. 2d Lieut., Engineers, U. S. A., Co. B, 303d Engrs.

Gross, Henry McC. 1st Lieut., 149th Div., Machine Gun Bn., A. E. F., France.

Grunauer, Mortimer. Sergeant, Headquarters Co., 304th F. A., A. E. F., France.

Gunther, Herman Dietrich. Co. B, 147th Inf.

Guppy, Benjamin Wilder. Maj., Engineers, U. S. A., 14th Engrs. (Ry.), A. E. F., France.

Guptill, Joseph R. Private, Co. E, 23d Engrs., A. E. F., France.

Gutman, David. Maj., Engineers, U. S. A.

Haas, Philip L. Capt., Engineers, U. S. A.

Hains, Peter C. Maj.-Gen., U. S. A.

Halcombe, N. M. Capt., Royal Flying Corps, Egypt.

Haldeman, Walter S. Capt., Engineers, U. S. A.

Hale, Richard King. Lt.-Col., 101st F. A., A. E. F., France.

Hall, Benjamin M., Jr. 1st Lieut., Engineers, U. S. A., Co. B, 26th Engrs., A. P. O. No. 701, A. E. F., France.

Hall, Charles L. Lt.-Col., Engineers, U. S. A., Headquarters, A. E. F., France.

Hall, Gilbert G. 1st Lieut., Engineers, U. S. A., 20th Engrs.

Hall, Julius R. 1st Lieut., Engineers, U. S. A., 515th Service Bn.

Hall, Louis W. Capt., Engineers, U. S. A., Care, Director of Const. and Forestry, S. O. S., P. O. 717, A. E. F., France.

Hall, Oliver Antrum. Capt., Engineers, U. S. A., 23d Engrs., U. S. A. P. O. 738, A. E. F., France.

Hall, Warren E. Capt., Engineers, U. S. A., Co. D, 506th Engrs. (Service Bn.), Base No. 2, A. E. F., France.

Hallberg, Arthur S. 1st Lieut., U. S. N. R. F., U. S. S. *Quinnebaug*.

Hallihan, John P. Maj., Engineers, U. S. A.

Halsema, E. J. Capt., Engineers, U. S. A.

Hamilton, Edward P. 2d Lieut., Field Artillery, U. S. A., 306th F. A.

Hammond, John M. Capt., Quartermaster Corps, U. S. A.

Hanavan, William L. 1st Lieut., 9th Inf.; Adjt., 2d Bn., A. E. F., France.

Hancock, Henry Sydney, Jr. Lieut., Royal Engrs.; Field Engr., First Corps, B. E. F., France.

Hanique, Jules E. Maj., Engineers, U. S. A., 537th Engrs., A. E. F., France.

Hannan, David E. Capt., Engineers, U. S. A., A. E. F., France.

Hansen, Paul. Capt., Engineers, U. S. A. Headquarters, Advance Section, S. O. S., Office of Chf. Engr., A. E. F., France.

Hapgood, Frederic H. Co. A, 26th Engrs., A. E. F., France.

Hardaway, Benjamin H., Jr. Maj., U. S. A.

Harding, Chester. Lt.-Col., Engineers, U. S. A., Balboa Heights, Canal Zone, Panama.

Harding, Ralph L. Capt., Engineers, U. S. A., 35th Engrs.

Harley, Alfred F. Field Clerk, Engineers, U. S. A., A. E. F., France.

Harmon, W. G. Capt., Sanitary Corps, U. S. A.

Harrah, O. W. Capt., Engineers, U. S. A., 319th Engrs.

Harris, F. R. Rear-Admiral, U. S. N.

Harris, Frank S. M. Lieut. (Senior Grade), U. S. N. N. V.

Harrison, William Burr. Maj., Engineers, U. S. A.

Hart, S. A. 1st Lieut., Engineers, U. S. A., 23d Engrs.

Harter, A. F. Capt., Engineers, U. S. A.

Harts, William W. Brig.-Gen., U. S. A., G. H. Q., 1er Echelon, B. E. F., France.

Hasbrouck, Oscar. Capt., Engineers, U. S. A., 522d Engrs.

Haskins, C. A. Capt., Sanitary Corps, U. S. A.

Haskins, John C. 1st Lieut., Engineers, U. S. A., 22d Engrs.

Hastings, R. P. 1st Lieut., Engineers, U. S. A., Co. D, 26th Engrs.

Hatch, Frederick N. Capt., Engineers, U. S. A., 35th Engrs., A. E. F., France.

Hauser, Kenneth D. Capt., 18th Engrs. (Ry.), A. E. F., France.

Hawley, John B. Maj., Engineers, U. S. A., 503d Engrs., Service Bn., A. E. F., France

Haydock, Charles. Co. 3, E. O. T. S., Camp Humphreys, Va.

Hayes, F. Eugene, Jr. Chf. Carpenter's Mate, U. S. N.

Hays, Donald S. Capt., Engineers, U. S. A.

Hays, John Coffee. Maj., Quartermaster Corps, U. S. A.

Hazlehurst, James Nisbet. Maj., Engineers, U. S. A., Headquarters, S. O. S., A. E. F., France.

Healey, Charles F. Capt., Engineers, U. S. A., A. P. O. No. 701, A. E. F., France.

Hebard, R. W. Maj., 5th Bn., 22d Engrs., A. E. F., France.

Heck, Nicholas H. Lieut., U. S. N. R. F.

Heed, Samuel D. Capt., Ordnance, U. S. A.

Hendricks, Ernest D. Capt., Engineers, U. S. A., Co. B, 303d Engrs.

Hendrie, John Gibson. Capt., Engineers, U. S. A.; Adjt., 2d Bn., 318th Engrs. (Sappers).

Henning, Charles S., Jr. Master Engr., Co. A, 21st Engrs., A. E. F., France.

Henry, Earle Underwood. 1st Lieut., Engineers, U. S. A., 116th Engrs., Care, D. G. T., A. P. O. No. 717, A. E. F., France.

Herkness, Lindsay C. Lt.-Col., Engineers, U. S. A., 302d Engrs.

Herzig, Solon. 1st Lieut., Engineers, U. S. A., Co. F, 25th Engrs., A. E. F., France.

Heslop, D. G. Capt., Royal Engrs., O. C. Surveys, Light Rys., E. E. F., Palestine.

Heuer, W. H. Col., U. S. A. (*Retired*).

Hewett, M. W. 1st Lieut., Engineers, U. S. A., 508th Service Bn.

Hews, Wellington P. Capt., Engineers, U. S. A., 62d Engrs., A. E. F., France.

Hickok, Clifton E. Capt., Engineers, U. S. A.

Higgins, Charles H. Maj., Ordnance, U. S. A.

Hilder, Frazer C. Capt., Engineers, U. S. A., Goring Hotel, Grosvenor Gardens, London, W. 1, England.

Hiles, Elmer K. Maj., 15th U. S. Engrs. (Ry.), A. E. F., France.

Hilton, Harry L. Asst. Civ. Engr., U. S. N. R. F.

Hinrichs, Adolf. 1st Lieut., Co. 5, E. O. T. S., Camp Humphreys, Va.

Hirzel, Alfred Sparks. Capt., 1st Delaware Inf.

Hjorth, Lawrence R. Co. C, 302d Field Sig. Bn.

Hoad, William C. Maj., Sanitary Corps, U. S. A.

Hoar, Allen. Civ. Engr., U. S. N. R. F.

Hobbs, Henry W. Maj., Engineers, U. S. A.

Hodge, Henry W. Col., Railroad Transportation Corps, U. S. A.; Mgr. of Roads, G. H. Q., A. E. F., France.

Hodges, H. F. Maj.-Gen., U. S. A.

Hoffman, Eugene R. Private, Headquarters Detachment, 26th Engrs., A. E. F., France.

Hogan, John P. Capt., 11th Engrs. (Ry.), A. E. F., France.

Holborn, Lewis A. Lieut., U. S. A., 22d Engrs.

Hollyday, R. C. Civ. Engr., U. S. N. (rank of Captain).

Holstlaw, Charles Henry. 1st Lieut., Infantry, U. S. A., 124th Inf.

Holt, Andrew H. Capt., Engineers, U. S. A.

Honeyman, Bruce R. Capt., Engineers, U. S. A., Co. A, 313th Engrs.

Hoopes, Edgar M., Jr. Capt., Quartermaster Corps, U. S. A.

Hoover, A. Pearson. Maj., Quartermaster Corps, U. S. A.

Hopkinson, George Martin. Capt., Quartermaster Corps, U. S. A.

Hopper, Jean G. L. Secy. to Capt. Escale, 3d Reg. de Marche, I^en^ Etranger (Foreign Legion), 43 Avenue de l'Opera, Paris, France.

Horton, C. K. Capt., Engineers, U. S. A.; Adjt., 2d Bn., 111th Engrs., A. E. F., France.

Horton, Dwight Fred. Capt., Engineers, U. S. A.

Hough, David L. Maj., Quartermaster Corps, U. S. A.

Howard, Conway Robinson. 1st Lieut., 17th Engrs. (Ry.), A. E. F., France.

Howard, Gerald B. 1st Lieut., Engineers, U. S. A., Co. E, 17th Engrs. (Ry.), A. E. F., France.

Howard, Robert C. Capt., Engineers, U. S. A.

Howe, Wilson Tyler. Capt., Quartermaster Corps, U. S. A.

Howell, Clarence S. Capt., Engineers, U. S. A., Co. 4, E. O. T. S., Camp Humphreys, Va.

Howell, George P. Col., Engineers, U. S. A.

Howell, Robert P. Capt., Quartermaster Corps, U. S. A.

Hoxie, Richard L. Brig.-Gen., U. S. A. (*Retired*).

Huber, Joseph E. Care, 1st Training Co., 5th C. A. Training Camp, Fort Monroe, Va.

Huber, William T. Capt., Engineers, U. S. A.

Hudson, H. W. Maj., Staff of Director-Gen. of Transportation, Care, Director-Gen. of Transportation, A. E. F., France.

Hughes, George L. 2d Lieut., Engineers, U. S. A.

Huie, Irving V. A. Capt., Co. B, 1st Engrs., U. S. A., A. E. F., France.

Hull, George B. Maj., Canadian Forestry Corps, Care, C. H. Orme, Prince Rupert, B. C., Canada.

Hull, Gordon B. Gifford. Capt., Royal Engrs.; The Grange, Horton, Northampton, England.

Hulsart, C. Raymond. Capt., Co. B, 11th Engrs. (Ry.), A. E. F., France.

Humann, Edwin August. Private, Co. D, 4th Engrs.

Humphrey, Gilbert Edwin. Maj., Engineers, U. S. A.

Humphreys, Charles Raymond. Capt., U. S. A., 105th Engrs.

Humphreys, Ewing S. 1st Lieut., Engineers, U. S. A.

Hunt, Charles A. Civ. Engr., U. S. N. R. F.

Hunt, Conway B. Maj., Engineers, U. S. A. (*Unassigned*).

Hunt, Leigh A. Maj., 110th Engrs., A. E. F., France.

Hurlbut, H. B. Capt., Ordnance, U. S. A.

Hurley, John Patrick. Capt., Co. K, 165th Inf., A. E. F., France.

Husson, William M. Capt., U. S. A., 82d F. A.

Husted, Alva Guy. Capt., Sanitary Corps, U. S. A.

Huston, Tillinghast L'Hommedieu. Maj., Engineers, U. S. A., 1st Bn., 16th Engrs. (Ry.), A. E. F., France.

Hyde, Charles G. Capt., Sanitary Corps, U. S. A., Bn. 7, Co. 28.

Hyde, Richard Lewis. 2d Lieut., Engineers, U. S. A., 10th Engrs., A. E. F., France.

Hynds, Harold D. 1st Lieut., Signal Corps, Aviation Section, U. S. A.

Ingalls, O. L. Maj., Engineers, U. S. A.

Irish, Leland W. Master Engr., 42d Bn., 20th Engrs.

Jackson, Dugald C. Maj., Engineers, U. S. A., A. E. F., France.

Jackson, Jesse A. Maj., 116th Bn., 41st Div., Signal Corps, U. S. A.

Jackson, W. B. Maj., Quartermaster Corps, U. S. A.

Jacobosky, Gilbert G. Capt., Co. B, 55th Engrs., A. E. F., France.

Jacobs, Joseph. Maj., Engineers, U. S. A., 509th Engrs. (Service Bn.), A. E. F., France.

Jacobson, Alfred Leon. Capt., Commandant, 26^{me} Batterie, 246^{me} Reg. d'Artillerie de Campagne, Secteur Postal 30, Armée Française en Campagne, France.

Jacques, Henry L. Capt., Engineers, U. S. A.

Jaenicke, William H. 2d Lieut., Engineers, U. S. A.

James, Alfred R. 1st Lieut., Quartermaster Corps, U. S. A.

James, Frank T. Capt., Engineers, U. S. A.

James, Robert Lane. 2d Lieut., 17th Engrs. (Ry.), A. E. F., France.

Jaques, J. D. Civ. Engr., U. S. N. R. F. (rank of Lieut.).

Jasper, T. McLean. Capt., Imperial Forces; Director of Signalling, No. 2, R. G. A., Cadet School, Maresfield Park, Sussex, England.

Jenkins, Charles M. Capt., Engineers, U. S. A.

Jenkins, Jenks B. Maj., Engineers, U. S. A.

Jennings, Percy J. Capt.; Adjt., 5th Pioneers Canadians (late 4th Pioneers), Care, Canadian Bank of Commerce, 2 Lombard St., London, E. C., England.

Jerrard, Leigh P. 2d Lieut., Engineers, U. S. A., Headquarters, 67th Artillery Brigade, A. E. F., France.

Jervey, Henry. Brig.-Gen., U. S. A.

Jessup, Walter E. 1st Lieut., Engineers, U. S. A., Co. C, 39th Engrs.

Jewell, Albert Hartwell. 1st Lieut., Sanitary Corps, U. S. A., Co. F, 26th Engrs., A. E. F., France.

Jewett, Thomas E. Capt., Quartermaster Corps, U. S. A.

Johnson, Francis Whittier. Lieut., Coast Artillery, U. S. A.

Johnson, Frank Melvin S. Capt., Engineers, U. S. A., 4th Div., 4th Engrs., A. E. F., France.

Johnson, George A. Maj., Quartermaster Corps, U. S. A.

Johnson, Halbert T. Private, Student Detachment No. 3, 472d Engrs.

Johnson, Hollister. 2d Lieut., Engineers, U. S. A., Co. C, 1st Bn., 20th Engrs., A. E. F., France.

Johnson, J. M. Lt.-Col., 117th Engrs., A. E. F., France.

Johnson, Louis R. Capt., Engineers, U. S. A.

Jonah, F. G. Maj., Engineers, U. S. A.; Chf. Engr., Dept., Light Rys., U. S. Army P. O. 706, A. E. F., France.

Jones, Harry E. Private, Aviation Section, Signal Corps, U. S. A., Meteorological Section.

Jones, Henry L. Maj., Engineers, U. S. A. (*Unassigned*).

Jones, John H. Capt., 1st Canadian Pioneers, B. E. F., France.

Jones, Jonathan. Capt., Engineers, U. S. A., 23d Engrs.

Jones, Lewis Allen. Capt., Engineers, U. S. A.

Jones, Paul Sidney. Co. 2, E. O. T. C., Camp Humphreys, Va.

Jones, Percival C. Corporal, Co. G, 23d U. S. Engrs., A. P. O. 716, A. E. F., France.

Jones, Sidney G. Capt., Engineers, U. S. A., Headquarters Co., 35th Engrs., A. P. O. 735, A. E. F., France.

Jordan, Harry E. Capt., Quartermaster Corps, U. S. A.

Joseph, Jacob. Private, Meteorological Section, Signal Corps, U. S. A., A. E. F., France.

Jouine, G. P. F. Sous Lieut. au 81eme Regt. d'Artillerie, A. S. 14, par B. C. M., France.

Judson, William V. Lt.-Col., Engineers, U. S. A.

Kane, Daniel C. 1st Lieut., Engineers, U. S. A., 466th Pontoon Train.

Kane, Irving P. Capt., Engineers, U. S. A., 45th Engrs., A. E. F., France.

Karnopp, Edwin B. Capt., Engineers, U. S. A., 2d Bn., 22d Engrs.

Kastenhuber, E. G., Jr. Capt., Sanitary Corps, U. S. A.

Kaufmann, Ernst G. Private, 499th Aero Squadron.

Keenan, John T. Maj., Engineers, U. S. A., 2d Bn., Headquarters, 28th Engrs. (Quarry), A. E. F., France.

Keith, Gerald Marcy. Lieut., Engineers, U. S. A., Co. B, 116th Engrs., A. E. F., France.

Keller, Arthur R. Capt., Engineers, U. S. A.

Keller, Charles. Col., Engineers, U. S. A.

Kelly, Earl W. Capt., Engineers, U. S. A.

Kelly, Hugh Ambrose. Lieut., Engineers, U. S. A.

Kelly, William. Col., Engineers, U. S. A., 117th Engrs., A. E. F., France.

Kemp, John E. Capt., Engineers, U. S. A.; Chf. Engr., Ordnance Depot in France, Care, J. H. Hood, 4 rue d'Auber, Paris, France.

Keys, Edward A. Capt., Engineers, U. S. A., Co. C, 511th Engrs. (Service Bn.), U. S. A. P. O. 708, A. E. F., France.

Khachadoorian, H. H. 1st Lieut., Engineers, U. S. A., Co. C, 55th Engrs.

King, Clifford M. Capt., Engineers, U. S. A., 313th Engrs.

King, Eric T. Maj., Quartermaster Corps, U. S. A.

King, Howard L. 2d Lieut., Engineers, U. S. A., Co. B, 27th Engrs.

King, Thomas R. 1st Lieut., Engineers, U. S. A., A. E. F., France.

King, W. S. Capt., Quartermaster Corps, U. S. A.

Kingsley, E. A. Maj., Engineers, U. S. A., A. E. F., France.

Kingsley, George. Capt., Engineers, U. S. A.

Kinne, G. W. Capt., Engineers, U. S. A.

Kinnear, Lawrence W. 2d Lieut., Aviation Section, Signal Corps, U. S. A.

Kipp, Frederick M., Jr. 33d Engrs., U. S. A.

Kirby, Luther H. Capt., Engineers, U. S. A.

Kirschner, Charles. Student (Private), E. O. T. S., Camp Humphreys, Va.

Kissack, A. B. Capt., Engineers, U. S. A.

Kitchen, Ernest. 1st Lieut., Engineers, U. S. A.

Kittredge, Frank A. Capt., U. S. A., 43d Engrs., A. E. F., France.

Kittredge, Harry C. Capt., Engineers, U. S. A.

Kitts, Joseph A. Capt., Engineers, U. S. A., U. S. A. P. O. 701, A. E. F., France.

Kleinschmidt, H. S. Capt., U. S. A.

Klinck, J. H. Maj., Quartermaster Corps, U. S. A.

Kluegel, Harry A. Capt., Quartermaster Corps, U. S. A.

Knight, G. W. Capt., Engineers, U. S. A., 46th Engrs., A. E. F., France.

Kniskern, Philip Wheeler. Capt., Engineers, U. S. A.

Knollman, Enno P. Ensign, U. S. N. R. F.

Knost, W. A. 1st Lieut., Coast Artillery, U. S. A.

Koop, Louis D. Capt., Quartermaster Corps, U. S. A.

Krach, Fred R. Private, Co. A, 23d Engrs.

Kreamer, A. W. 1st Lieut., Engineers, U. S. A. (*Unassigned*).

Krigbaum, Lowell G. 1st Lieut., Engineers, U. S. A., Care, Director of C. and F., A. E. F., France.

Kutz, Charles W. Brig.-Gen., U. S. A.

La Bach, Paul M. Maj., Engineers, U. S. A., A. E .F., France.

Labsap, Alfred H. 1st Lieut., Engineers, U. S. A., 114th Engrs.

La Forge, Frederick W. Maj., Engineers, U. S. A.

Lake, Edward N. Maj., Quartermaster Corps, U. S. A.

Lamb, Lyman C. Capt., Engineers, U. S. A.

Lambert, Byron J. Maj., Engineers, U. S. A., 23d Engrs. (Highway).

Lamphere, Frank E. Col., Quartermaster Corps, U. S. A.

Lamson, William M. Maj., Engineers, U. S. A., 306th Engrs.

Lancashire, Forest H. Capt., Engineers, U. S. A.

Land, John T. Capt., Engineers, U. S. A.

Lansdale, John. Capt., Engineers, U. S. A., Military Post Office No. 701, A. E. F., France.

Larkin, C. Raymond. Reclamation Officers' Training Camp, Camp Joseph E. Johnston, Fla.

La Roche, Arthur L. 1st Lieut., Engineers, U. S. A., A. E. F., France.

Larrison, George K. Capt., Engineers, U. S. A., Headquarters, Hawaiian Dept., U. S. A., Honolulu, Hawaii.

Lathbury, Benjamin Brentnall. Maj., Ordnance, U. S. A.

Latimer, C. A. 2d Lieut., Engineers, U. S. A., Co. E, 3d Engrs., Corozal, Canal Zone, Panama.

Laughlin, Harmon L. Capt., Engineers, U. S. A.; Topographical Officer, 108th Engrs.

Laverty, Samuel Perry. Regt. Sup. Sergeant, 316th Am. Tr.

Lawrence, Frank Elmaker. Capt., 17th Engrs. (Ry.), A. E. F., France.

Lawton, Richard M. Maj., Engineers, U. S. A., A. P. O. 721, A. E. F., France.

Learned, A. P. 1st Lieut., Sanitary Corps, U. S. A.

LeBaron, R. W. P. 1st Lieut., Co. C, 13th Engrs. (Ry.), A. E. F., France.

Leckie, Alexander R. Capt., U. S. A., 111th Engrs.

Lee, Alonzo Church. 1st Lieut., Infantry, U. S. A., 17th Machine Gun Bn.

Lee, Augustine L. Maj., U. S. A., C. O. 504th Engrs., Camp A. A. Humphreys, Va.

Lee, Charles A. Lieut. (Senior Grade), U. S. N. R. F.

Lee, Charles H. 1st Lieut., Engineers, U. S. A., Care, Chf. Engr. Officer, A. E. F., A. P. O. 717, Water Supply Section, A. E. F., France.

Lee, John Louis. Maj., Quartermaster Corps, U. S. A.

Leeds, Charles T. Capt., U. S. A.

Lehrbach, Henry G. Asst. Civ. Engr., U. S. N. (rank of Lieut. (Junior Grade)).

Leisen, Theodore A. Maj., Quartermaster Corps, U. S. A.

Leiser, F., Jr. 30th Tr. Bn., Field Artillery Central Officers' Training School, Camp Zachary Taylor, Ky.

Leland, O. M. Lt.-Col., Engineers, U. S. A., 303d Engrs., A. E. F., France.

Lemen, William C. S. Capt., Engineers, U. S. A.

Leonard, O. Y. 1st Lieut., Ordnance, U. S. A.

Letton, Harry P. Capt., Engineers, U. S. A., A. E. F., France.

Lewis, Charles Granville. Private, Co. A, 21st Engrs., A. E. F., France.

Lewis, F. H. Maj., Engineers, U. S. A.

Lewis, Harold McLean. 2d Lieut., Co. A, 502d Engrs., A. E. F., France.

Lewis, Luther H. Maj., Quartermaster Corps, U. S. A.

Libbey, V. B. Lieut., Engineers, U. S. A., A. E. F., France.

Lightner, George W. C. Capt. and Supply Officer, 21st Engrs. (Light Ry.), A. E. F., France.

Lilly, Ridgely C. Lieut., Engineers, U. S. A. (*Unattached*), A. E. F., France.

Lindhé, John B. Lieut., U. S. N. R. F., P. O. Box 781, Balboa, Canal Zone, Panama.

Lineberger, Walter Franklin. Capt., Engineers, U. S. A.

Linsley, Charles Wells. Asst. Civ. Engr., U. S. N. R. F. (rank of Lieut. (Junior Grade)).

Lipari, A. F. Private, Aviation Section, Signal Corps, U. S. A.

Lisman, Oliver C. 1st Lieut., U. S. A., 519th Engrs.

Livermore, Norman B. Capt., Engineers, U. S. A., A. E. F., France.

Livingston, Archibald R. Maj., Engineers, U. S. A., 115th Engrs.

Lockhardt, William Francis. 1st Lieut., Quartermaster Corps, U. S. A.

Lockwood, Richard J. 2d Lieut., Field Artillery, U. S. A.

Logan, Chester R. Capt., Co. C, 502d Engrs., A. E. F., France.

Logan, Vernon L. 2d Lieut., U. S. A., 530th Engrs.

Longley, Francis F. Lt.-Col., 26th Engrs., A. E. F., France.

Lord, Arthur R. Capt., Engineers, U. S. A.

Louckes, Frank I. Capt., Engineers, U. S. A., Inland Water Transportation Service, A. P. O. 702, A. E. F., France.

Loughran, James F. Asst. Civ. Engr., U. S. N. R. F. (rank of Lieut. (Junior Grade)).

Lovering, Harry D. 1st Lieut., Engineers, U. S. A.

Lowe-Brown, William L. Lt.-Col., R. E. (British Army), River Plate House, Finsbury Circus, London, E. C. 2, England.

Lucas, E. W. Van C. Lt.-Col., U. S. A., 304th Engrs.

Luiggi, Luigi. Col.; Insp. of Munition Factories in Central Italy, Via Bonconpagni 17, Rome, Italy.

Lumsden, Hugh J. Capt., Quartermaster Corps, U. S. A.

Lund, Alfred M. Maj., Sanitary Corps, U. S. A.

Lundgren, Leonard. Capt., 116th Engrs., A. P. O. 714, A. E. F., France.

Lynch, John F. Capt., Engineers, U. S. A., Co. D, 1st Bn., 1st Replacement Engrs.

Lyon, George J. Capt., Engineers, U. S. A.

Lyon, Léon E. Maj., Railroad Transportation Corps, A. E. F., France.

Lyons, Harold C. 1st Lieut., Engineers, U. S. A., Co. B, 1st Bn., 20th Engrs., A. E. F., France.

Macartney, Morton. Maj., Quartermaster Corps, U. S. A.

MacDiarmid, Milo S. Maj., Engineers, U. S. A.

MacGlashan, Alexander. Maj., U. S. A., 104th Engrs.

Machen, Henry B. Maj., Ordnance, U. S. A.

Macintosh, P. H. M. Capt., Tropical Force (Australia), Officers' Camp, British Prisoners of War, Heidelberg, Germany.

Mackenzie, Alexander. Maj.-Gen., U. S. A. (*Retired*).

Mackenzie, Leon R. Capt., Quartermaster Corps, U. S. A.

MacNaughton, Percival J. Asst. Civ. Engr., U. S. N. R. F.

Macomb, John de N., Jr. Capt., Engineers, U. S. A., A. E. F., France.

McCalla, W. A. Maj., Engineers, U. S. A., 504th Engr. Bn. (Service), A. E. F., France.

McCandliss, Edgar S. Capt., Engineers, U. S. A., 314th Engrs.

McCandliss, L. C. 1st Lieut., Co. D, 15th Engrs. (Ry.), Field Headquarters, A. E. F., France.

McClean, George Thomas. Capt., Engineers, U. S. A., 29th Engrs., A. P. O. 702, A. E. F., France.

McClellan, George A. Lieut., Aviation Section, Signal Corps, U. S. A.

McClintock, Hallett Edward. Capt., Engineers, U. S. A., Care, D., C., and F., A. P. O. 717, A. E. F., France.

McClure, Hunter. 1st Lieut., Engineers, U. S. A.

McComb, Dana Quick. Capt., Engineers, U. S. A., Fort Mills, Corregidor, Philippine Islands.

McConnell, Edward Herbert. 1st Lieut., Engineers, U. S. A., A. E. F., France.

McCullough, Ernest. Maj., Engineers, U. S. A., Gas Service, Headquarters, A. E. F., France.

McDermith, Oro. Capt., Engineers, U. S. A.

McDonald, Harry L. Capt., Engineers, U. S. A.

McDonnell, Francis R. Lieut. (Junior Grade), U. S. N. R. F.

McDonough, Michael J. Col., U. S. A., 114th Engrs.

McFarland, H. F., Jr. 1st Lieut., Co. F, 12th Engrs. (Ry.), A. E. F., France.

McGee, Arthur B. Sergeant, Ordnance, U. S. A.

McGee, Harold G. 1st Lieut., Sanitary Corps, U. S. A.

McGee, Roger K. Capt., Engineers, U. S. A.

McGeehan, Paul. Capt., Co. D, 12th Engrs. (Ry.), A. E. F., France.

McGlathery, Sam L. Capt., Engineers, U. S. A., 312th Engrs., A. E. F., France.

McGregor, Robert Roy. Capt., U. S. A., 21st Engrs.

McGrew, John A. Maj., Quartermaster Corps, U. S. A.

McIntosh, Samuel F. Capt., Ordnance, U. S. A.

McKay, George A. Civ. Engr., U. S. N. (rank of Commander).

McKenney, Charles A. Maj., Engineers, U. S. A.

McKinstry, Charles Hedges. Brig.-Gen., U. S. A., 67th F. A. Brigade, A. E. F., France.

McLane, G. L. Capt., Engineers, U. S. A.; Adjt., 110th Engrs.

McLoud, Paul. 1st Lieut., Engineers, U. S. A., Co. F, 11th Engrs., A. E. F., France.

McMeekin, Charles William. Maj., Engineers, U. S. A.

McMillan, W. Bruce. 1st Lieut., Engineers, U. S. A., A. E. F., France.

McMullen, Clements. Lieut., Aviation Section, Signal Corps, U. S. A.

McNayr, George E. 2d Lieut., Engineers, U. S. A., 33d Engrs.

McRae, H. C. 1st Lieut., Engineers, U. S. A., 45th Engrs., A. E. F., France.

Maddock, Thomas. 1st Lieut., U. S. A., 43d Engrs.

Maddox, L. R. Capt., 17th Engrs., Regulating Station "A," Supply Office, U. S. P. O. No. 712, A. E. F., France.

Mahon, John M., Jr. Capt., Sanitary Corps, U. S. A.

Mail, Eugene Frederick. 1st Lieut., Engineers, U. S. A., 4th Engrs.

Malloy, John Michael. Lieut., U. S. A., 342d F. A.

Malsbury, Omer Evert. Capt., Engineers, U. S. A., 3d Engrs., Corozal, Canal Zone, Panama.

Maltby, Frank B. Maj., Engineers, U. S. A., A. E. F., France.

Mandigo, Clark R. Capt., Engineers, U. S. A., 314th Engrs.

Mangold, John Frederic. Capt., Engineers, U. S. A. (*Unassigned*).

Manning, William J. H. 2d Lieut., Engineers, U. S. A., 52d Engrs., A. E. F., France.

Mansfield, Newton. Lt.-Commander, U. S. N. (*Retired*).

March, George Miles. 1st Lieut., Engineers, U. S. A., 507th Engrs.

Marks, Edwin H. Lt.-Col., Engineers, U. S. A., 20th Engrs.

Marrian, Ralph R. 2d Lieut., Engineers, U. S. A., Co. B, 105th Engrs.

Marshall, Robert B. Maj., Engineers, U. S. A.

Marston, Anson. Maj., Engineers, U. S. A.

Martin, James Walter. Capt., Engineers, U. S. A.

Marx, Raymond. 2d Lieut., Co. K, 308th Inf., A. E. F., France.

Maslen, Harold C. Ensign, U. S. N. R. F.

Massei, Caesar. Maj., Engineers, U. S. A., 22d Engrs.

Massey, George B. Lieut. (Junior Grade), U. S. N. R. F.

Massey, Walter F. Private, Co. 15, Recruit Bn., 5th Engr. Tr. Reg., Camp Humphreys, Va.

Masters, F. M. Maj., Ordnance, U. S. A.

Maul, Theodore R. Capt., Quartermaster Corps, U. S. A., A. E. F., France.

Maury, Dabney H. Lt.-Col., Quartermaster Corps, U. S. A.

Maxson, Frank O. Civ. Engr., U. S. N. (*Retired*).

Mayo, George. Capt., Engineers, U. S. A., 5th Engrs.

Mazeau, Camille. 1st Lieut., Coast Artillery, U. S. A., Battery F, 56th Artillery.

Means, John S. 2d Lieut., Engineers, U. S. A., 508th Engrs.

Mears, Frederick. Col., U. S. A., 31st Engrs., A. P. O. 718, Care, D. G. T., A. E. F., France.

Melin, Reynold F. 1st Lieut., Ordnance, U. S. A.

Mellon, Albert E. Capt., Heavy Artillery, U. S. A., A. E. F., France.

Melton, Arthur Pomeroy. Capt., Engineers, U. S. A., Headquarters, Lines of Communication, A. E. F., France.

Mendenhall, Herbert D. Capt., Engineers, U. S. A., U. S. M. P. O. 705, A. E. F., France.

Menefee, Ferdinand N. Capt., Ordnance, U. S. A.

Mengel, Carl W. 1st Lieut., Engineers, U. S. A., Co. B, 306th Engrs.

Merriam, C. A. Capt., Engineers, U. S. A.

Mershon, Ralph D. Maj., Engineers, U. S. A.

Messer, Hope Richard. Maj., Quartermaster Corps, U. S. A.

Miles, George Frederick. Capt., Engineers, U. S. A.; Adjt., 8th Bn., 20th Engrs., A. E. F., France.

Milhan, David N. 1st Lieut., Engineers, U. S. A., Co. F, 106th Engrs.

Milkowski, V. J. 2d Lieut., Engineers, U. S. A.

Miller, Charles H. Maj., Engineers, U. S. A., 23d Engrs., 2nd Bn., A. E. F., France.

Miller, Daniel C. 1st Lieut., Engineers, U. S. A.

Miller, George S. Maj., Engineers, U. S. A.

Miller, Hugh. Capt., Engineers, U. S. A.

Miller, John O. 2d Lieut., Infantry, U. S. A.

Miller, K. A. Sergeant, Co. F, 603d Engrs., A. E. F., France.

Millis, John. Col., Engineers, U. S. A.

Mills, A. P. Capt., Engineers, U. S. A.

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Reed, Paul Lyon. Civ. Engr., U. S. N. (rank of Commander).

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Roberts, Leo Bond. Lieut., Engineers, U. S. A., 25th Engrs.

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Smith, Albert. Maj., U. S. A., 2d Bn., 309th Engrs.

Smith, Alexander Crawford, Jr. 1st Lieut., Engineers, U. S. A., Truck Co. No. 10, 23d Engrs., A. E. F., France.

Smith, Charles E. Maj., Quartermaster Corps, U. S. A.

Smith, Chester Alexander. Capt., Sanitary Corps, U. S. A.

Smith, Chester K. Capt., Engineers, U. S. A., Care, Director of Constr. and Forestry, Headquarters, S. O. S., A. E. F., France.

Smith, Claire Howland Wallace. 1st Lieut., Engineers, U. S. A. (*Unassigned*), A. E. F., France.

Smith, Clarence Urling. Capt., Co. E, 107th Engrs., A. E. F., France.

Smith, Clarke Stull. Col., Engineers, U. S. A., Headquarters, 311th Engrs.

Smith, Earl Audie. 1st Lieut., Engineers, U. S. A.

Smith, Edward King. 2d Lieut., Signal Corps, U. S. A.

Smith, Francis M. Capt., Engineers, U. S. A., Headquarters, 59th Engrs. (Ry.), U. S. A. P. O. 708, A. E. F., France.

Smith, Layton Fontaine. Lieut., U. S. N. R. F.

Smith, Maxwell W. Capt., Engineers, U. S. A., Co. F, 308th Engrs., A. E. F., France.

Smith, Merritt H. Col., 1st N. Y. Field Artillery, N. G. U. S.

Smith, Richard B. Private, Meteorological Section, Aviation Section, Signal Corps, U. S. A., 32d Service Co., A. E. F., France.

Smith, Robert C. Maj., Quartermaster Corps, U. S. A.

Smith, Schuyler M. 1st Lieut., Co. D, 12th Engrs. (Ry.), A. E. F., France.

Smith, Shaler G. Lieut. (Student), Co. 4, E. O. T. S., Camp Humphreys, Va.

Smith, W. W. Master Engr., 16th Engrs. (Ry.), A. E. F., France.

Smoot, Lloyd D. Capt., Quartermaster Corps, U. S. A.

Snell, Edward Beniah. 1st Lieut., Engineers, U. S. A.

Snodgrass, W. T. Sergeant, Co. C, 28th Engrs., A. E. F., France.

Snook, Thomas E., Jr. 1st Lieut., Engineers, U. S. A., Co. B, 306th Engrs.

Snyder, Frederic Antes. Col., U. S. A., 103d Engrs.

Snyder, George Duncan. Capt., U. S. A., 102d Engrs.

Snyder, Hubert Earl. Capt., Engineers, U. S. A.

Soest, Hugo C. 1st Lieut., Engineers, U. S. A., Co. A, 25th Engrs., A. E. F., France.

Solomon, G. R. Maj., Engineers, U. S. A.

Sourwine, J. A. Capt., Engineers, U. S. A.

Spear, Philip H. Capt., Engineers, U. S. A.

Spear, Walter E. Maj., Quartermaster Corps, U. S. A.

Spencer, Charles B. Lieut., Care, Chf. Ord. Officer, P. O. 717, A. E. F., France.

Spencer, Herbert. Capt., Engineers, U. S. A., Co. H, 23d Engrs., A. E. F., France.

Sperry, L. N. 1st Lieut., Engineers, U. S. A., 6th Engrs., A. E. F., France.

Sprague, H. M. 1st Lieut., Engineers, U. S. A., Care, G. P. A., Labor Bureau, A. P. O. 702, A. E. F., France.

Stafford, Fred D. Capt., Engineers, U. S. A., 105th Engrs., A. E. F., France.

Stallings, John R. Sergeant, Headquarters Co., 3d Anti-Aircraft Bn.

Stanford, Homer R. Civ. Engr., U. S. N. (rank of Commander).

Stanley, W. E. 1st Lieut., Engineers, U. S. A., Co. B, 101st Engrs., A. E. F., France.

Stanton, Charles B. Capt., Engineers, U. S. A., Co. E, 15th Engrs. (Ry.), A. E. F., France.

Stanton, W. L. 2d Lieut., Engineers, U. S. A., 304th Engrs.

Starr, F. Charles. Capt., Quartermaster Corps, U. S. A.

Starrett, William A. Col., Quartermaster Corps, U. S. A.

Stayton, Edward M. Maj., U. S. A., 110th Engrs.

Stearns, Fred LeRoy. Lieut., U. S. A., Co. A, 107th Inf.

Stearns, Ralph H. Lieut. (Junior Grade), U. S. N. R. F.

Steep, James B. Capt., Engineers, U. S. A.

Steese, James Gordon. Lt.-Col., Engineers, U. S. A.

Steeves, C. McN. Lieut., 9th Field Co., Canadian Engrs., B. E. F., France.

Stellhorn, Adolf. Capt., Engineers, U. S. A., Office, Chf. Engr., S. O. R., P. O. 717, A. E. F., France.

Stem, Clifford H. 2d Lieut., Engineers, U. S. A., 101st Engrs., L. of C., A. E. F., France.

Stephens, Uel. Lieut., U. S. A., 57th Inf.

Stern, Eugene W. Maj., Engineers, U. S. A.; Supt. of Roads, Care, C. G. Base Section No. 2, U. S. Military P. O. 705, A. E. F., France.

Stewart, John. Maj., Engineers, U. S. A.

Stewart, John T. Maj., Engineers, U. S. A.

Stickle, H. W. Lt.-Col., U. S. A. (*Retired*).

Stillwell, Howard L. 2d Lieut., Quartermaster Corps, U. S. A.

Stineman, Norman M. Capt., Engineers, U. S. A., 33d Engrs.

Stivers, A. D. Capt., Infantry, U. S. A.

Storey, Franklin S. 1st Lieut., Engineers, U. S. A., A. E. F., France.

Stowe, H. D. Capt., Engineers, U. S. A.

Strachan, Joseph J. Asst. Civ. Engr., U. S. N. (rank of Lieut. (Junior Grade)).

Strachan, Norman F. Private, 23d Engrs.

Strecker, R. A. Maj., Engineer, U. S. A., 2d Bn., 309th Engrs., A. E. F., France.

Street, J. Z. Private, Specialist Detachment, Co. A, 26th Engrs., A. E. F., France.

Strehan, George E. 2d Lieut., Field Artillery, U. S. A., Battery E, 351st F. A.

Strickler, G. B. Maj., Engineers, U. S. A.

Strickler, T. J. Capt., Engineers, U. S. A.

Stronach, Robert S. Lieut., 10th Field Co., Canadian Engrs., B. E. F., France.

Stuart, Edward. Capt., Sanitary Corps, U. S. A.

Stupp, John G. 1st Lieut., Ordnance, U. S. A.

Sturtevant, C. W. Lt.-Col., U. S. A., 15th Engrs., A. E. F., France.

Summers, R. E. J. 1st Lieut., Engineers, U. S. A., Co. F, 15th Engrs. (Ry.), A. E. F., France.

Suter, Russell. Capt., Engineers, U. S. A., Care, S. E. O., Int. Sect., S. O. S., A. E. F., France.

Sutton, Frank. Maj., Engineers, U. S. A., 29th Engrs.

Swaren, J. W. Capt., Engineers, U. S. A., Headquarters, 318th Engrs. (Sappers), A. E. F., France.

Swartz, Leon. Master Engr., 15th U. S. Engrs., A. E. F., France.

Sweeney, Harry C. Capt., Quartermaster Corps, U. S. A.

Sweetser, C. H. Capt., Engineers, U. S. A., Co. A, 43d Engrs., A. E. F., France.

Sweetser, E. O. Capt., Engineers, U. S. A. (*Unattached*), A. E. F., France.

Swett, Everett H. Capt., Engineers, U. S. A.

Sykes, George. Capt., Engineers, U. S. A., A. E. F., France.

Symonds, G. R. B. Capt., Engineers, U. S. A., Co. A, 605th Engrs.

Tainter, F. S. Maj., Engineers, U. S. A.

Tate, R. L. 1st Lieut., Engineers, U. S. A., 303d Engrs.

Tay, S. W. Lieut., U. S. N. N. V., U. S. S. *Wenonah.*

Taylor, Arthur. 1st Lieut., Engineers, U. S. A.

Taylor, Edwin A. Maj., Engineers, U. S. A., 526th Engrs., A. E. F., France.

Taylor, Harry. Brig.-Gen., U. S. A.; Chf. Engr., A. E. F., France.

Taylor, Henry. Capt., Engineers, U. S. A., 304th Engrs.

Taylor, Hugh M. Maj., U. S. A., Care, D. G. T., A. P. O. 762, A. E. F., France.

Taylor, Nelson. Lieut., U. S. N., U. S. S. *Bridgeport.*

Taylor, P. M. 2d Lieut., R. E., 237th Field Co., B. E. F., Italy.

Taylor, Seneca V. Capt., Coast Artillery, U. S. A.

Taylor, William T. Capt., Royal Flying Corps, B. E. F., France.

Taylor, Wyllys H. Capt., Engineers, U. S. A., 306th Engrs.

Ten Hagen, Henry. 2d Lieut., Engineers, U. S. A., 303d Engrs.

Tenney, Willis R. Capt., Engineers, U. S. A., Eng. Depot, U. S. A. P. O. 712, A. E. F., France.

Thomas, Charles D. Capt., Engineers, U. S. A., Co. B, 507th Engrs., A. E. F., France.

Thomas, W. E. Capt., Constr. Div., Quartermaster Corps, U. S. A.

Thomas, William Michael. Capt., Engineers, U. S. A.

Thompson, Sanford E. Maj., Engineers, U. S. A.

Thomsen, S. L. Capt., Engineers, U. S. A., Co. A, 57th Engrs., A. E. F., France.

Thomson, F. M. Capt., U. S. A., 39th Engrs., A. E. F., France.

Thornton, L. Earle. Civ. Engr., U. S. N. R. F. (rank of Lieut.), 4 Place Iena, Paris, France.

Throop, George H. Capt., Engineers, U. S. A., Co. E, 24th Engrs.

Thurber, Clinton D. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Thurston, Eugene T. Capt., Engineers, U. S. A.

Tilden, Charles Joseph. Capt., Engineers, U. S. A. (*Unassigned*).

Tinkham, Ralph R. Capt., Engineers, U. S. A.

Tinsley, R. B. Capt., Engineers, U. S. A., Co. C, 605th Engrs., A. E. F., France.

Tirrell, Charles Edwards. Signal Corps, Aviation Section (Non-Flying), U. S. A.

Todd, Frank Herbert. Maj., Quartermaster Corps, U. S. A.

Todd, Oliver J. Capt., Engineers, U. S. A., 20th Engrs., P. O. No. 780, A. E. F., France.

Tolles, F. C. 1st Lieut., Engineers, U. S. A., 112th Engrs.

Tomlinson, Alfred Thomas. Maj., Canadian Engrs.; Insp. Small Arms Ammunition, Dominion Arsenal, Lindsay, Ont., Canada.

Tompkins, Robert Harry. 1st Lieut., 111th Engrs., A. E. F., France.

Topping, Perry. Capt., Engineers, U. S. A., 5th Engrs.

Torrance, William M. Capt., Engineers, U. S. A.

Townsend, C. McD. Col., Engineers, U. S. A., 12th Engrs. (Ry.), A. E. F., France.

Toyne, John Wilson. Capt., Quartermaster Corps, U. S. A.

Tracy, C. C. Capt., Coast Artillery, U. S. A.

Tracy, Herbert Herman. 1st Lieut., Engineers, U. S. A., Engr. Wagon Co. 4, 23d Engrs., U. S. A. P. O. 708, A. E. F., France.

Travers=Ewell, Andrew. Care, American Consul, Para, Brazil.

Trimpi, Allan Littell. 1st Lieut., U. S. A., 104th Engrs.

Trout, Alexander Linn. Capt., Engineers, U. S. A. (*Unassigned*), A. E. F., France.

True, Albert O. Capt., Engineers, U. S. A.

Trueblood, P. McG. Lieut., U. S. N. R. F.

Tucker, H. F. Ensign, U. S. N. R. F.

Turley, Jay. Capt., Engineers, U. S. A., Care, Eng. Purchasing Officer, P. O. No. 702, A. E. F., France.

Turner, Daniel Norman. 2d Lieut., Engineers, U. S. A., 304th Engrs.

Turner, Nathaniel Parker. Capt., Co. B, 111th Engrs., A. E. F., France.

Tuska, Gustave R. Maj., Engineers, U. S. A.

Tyler, Richard G. Capt., Quartermaster Corps, U. S. A.

Tyson, William C. Capt., Engineers, U. S. A., Co. No. 2, Camp Custer Replacement Draft, A. E. F., France.

Uhler, W. D. Lt.-Col., Quartermaster Corps, U. S. A.

Van Amburgh, Thomas A. 1st Lieut., Quartermaster Corps, U. S. A.

Van Buren, Maurice Pelham. Capt., Engineers, U. S. A., 602d Engrs.

Vandemoer, N. C. Capt., Engineers, U. S. A.

Vanderhoof, Arnold H. Lieut., U. S. N. (*Retired*), Radio Div., Bureau of Steam Eng.

Vandervoort, B. F. Capt., Engineers, U. S. A.

Vandevanter, Elliott. Capt., Engineers, U. S. A., Co. D, 503d Engrs., A. E. F., France.

Van Ness, R. A. Lieut., Engineers, U. S. A.

Van Pelt, Sutton. Capt., Engineers, U. S. A., 110th Engrs.

Van Suetendael, Achille O. Capt., Engineers, U. S. A.

Van Zile, Harry Lee. Maj., Engineers, U. S. A., A. E. F., France.

Vaughan, Henry F. Capt., Sanitary Corps, U. S. A.

Verrill, George E. Maj., Engineers, U. S. A.

Vincent, W. H. 1st Lieut., Engineers, U. S. A.

Vogleson, J. A. Maj., Sanitary Corps, U. S. A.

Volk, Wendell Douglas. 1st Lieut., Engineers, U. S. A., Co. E, 20th Engrs., A. E. F., France.

von Deesten, A. P. Maj., Engineers, U. S. A.

Wade, George W. 1st Lieut., Co. D, 2d Bn., 117th Engrs., 42d Div., A. E. F., France.

Wadsworth, George R. Maj., Signal Corps, U. S. A.

Wadsworth, Henry H. Maj., Engineers, U. S. A. (*Unassigned*).

Wagner, John, Jr. 1st Lieut., Cavalry, U. S. A., First Corps School, Army P. O. No. 703, A. E. F., France.

Waite, Clement F. 1st Lieut., Engineers, U. S. A.

Waite, H. M. Lt.-Col., Railroad Transportation Corps, U. S. A., Care, Railroad Transportation Corps, A. E. F., France.

Waldron, Albert E. Col., U. S. A., 35th Engrs., A. E. F., France.

Walker, Edward G. Lieut., R. N. V. R.; 78 Cheyne Court, Chelsea, London, S. W. 3, England.

Walker, Elton D. Capt., Engineers, U. S. A., Co. A, 5th Engrs., A. E. F., France.

Walker, Harry Bruce. Capt., Engineers, U. S. A.

Walker, Meriwether Lewis. Col., Engineers, U. S. A., G. H. Q., A. E. F., France.

Walker, W. Kemp. Capt., Engineers, U. S. A.

Wallace, David A. Capt., Engineers, U. S. A., Headquarters, Director General of Transportation, A. P. O. 717, A. E. F., France.

Wallace, Harold U. Maj., Engineers, U. S. A.

Waller, Alexander C. 1st Lieut., Engineers, U. S. A., 22d Engrs., A. E. F., France.

Waller, Percy. Capt., Engineers, U. S. A.

Walter, Frank E. 1st Lieut., Co. B, 55th Engrs., A. E. F., France.

Walton, H. B. Capt., Engineers, U. S. A., 312th Engrs.

Wanzer, James O. 1st Lieut., 47th Engrs., A. E. F., France.

Ward, George S. 2d Lieut., Engineers, U. S. A., Co. A, 117th Engrs., A. E. F., France.

Ward, Jasper D. Corporal, Co. C, 55th Inf.

Ward, Lyman Wise. Capt., Coast Artillery, U. S. A.; Adjt., 1st Bn., 63d Artillery.

Ware, Howard T. 2d Lieut., Quartermaster Corps, U. S. A., Bakery Co. No. 317.

Ware, John. 1st Lieut., Co. A, 101st Engrs., A. E. F., France.

Ware, Norton. Capt., Engineers, U. S. A.

Warfield, Ralph M. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Waring, C. T. Maj., Signal Corps, U. S. A.

Warner, Elwin S. Capt., Engineers, U. S. A., Co. B, 301st Engrs.

Warnock, W. H. Capt., Quartermaster Corps, U. S. A.

Warren, Horace P. Maj., U. S. A., 55th Engrs., A. E. F., France.

Warren, James G. Col., Engineers, U. S. A.

Warren, Minton M. 1st Lieut., Engineers, U. S. A., Headquarters Co., 101st Engrs., 51st Brigade, 26th Div., A. E. F., France.

Warren, Philip R. Maj., Royal Engrs., P. C. E., A. P. O. S. 10, B. E. F., France.

Watkins, Guy A. Capt., Engineers, U. S. A.

Watson, D. M. Lieut., M. T., A. S. C., 100th Siege Battery, R. G. A., B. E. F., France.

Watson, George L. Capt., U. S. A., Co. B, 30th Engrs.

Watson, Winslow B. 1st Lieut., U. S. A., 106th Inf.

Watt, David A. Maj., Engineers, U. S. A.

Waugh, William H. Maj., Engineers, U. S. A.

Way, W. F. 2d Lieut., Co. D, 18th Engrs. (Ry.), U. S. Army Post Office No. 705, A. E. F., France.

Weaver, C. J. 1st Lieut., Engineers, U. S. A.

Weaver, Earll Chase. Asst. Civ. Engr., U. S. N. R. F.

Weaver, Frank L. Capt., Engineers, U. S. A., 305th Engrs.

Webb, Claude A. Lieut., Field Artillery, U. S. A., A. E. F., France.

Webb, De Witt Clinton. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Webb, George H. Lt.-Col., 16th U. S. Engrs. (Ry.), A. E. F., France.

Webb, I. Gano. Capt., Engineers, U. S. A.

Webb, Walter Loring. Maj., Engineers, U. S. A., A. E. F., France.

Webster, Maurice A. Capt., Ordnance, U. S. A.

Weeks, W. C. Maj., Engineers, U. S. A., 32d Engrs., Care, Y. M. C. A. Hotel for Officers, Paris, France.

Welden, Ernest. Private, Co. A, 43d Engrs., A. E. F., France.

Welles, Theodore L., Jr. 2d Lieut., Engineers, U. S. A.

Welsh, Russell D. Private, Co. F, 115th Engrs., A. E. F., France.

Wenige, Arthur E. Maj., Engineers, U. S. A., 317th Engrs.

Wenzell, Andrew P. Capt., Co. F, 16th U. S. Engrs. (Ry.), A. E. F., France.

West, Edward Hazzard. Capt., Engineers, U. S. A., 5th Engrs.

West, Wade C. Capt., Engineers, U. S. A.

Wheat, G. Neville. Capt., Engineers, U. S. A.

Wheeler, Frank I. 2d Lieut., Aviation Section, Signal Corps, U. S. A.

Wheeler, Robert C. Capt., Quartermaster Corps, U. S. A.

Wheelock, De Forest A. Col., U. S. A.

Whiteaker, Robert O. Capt., U. S. A., 132d F. A.

Whitman, Ezra B. Maj., Quartermaster Corps, U. S. A.

Whitman, Ralph. Civ. Engr., U. S. N. (rank of Lt.-Commander).

Whitney, C. S. Corporal, Co. F, 25th Engrs., A. P. O. 705, A. E. F., France.

Whitney, John T. 2d Lieut., Field Artillery, U. S. A., 2d Corps Artillery Park, A. E. F., France.

Whitney, Ralph Edward. 1st Lieut., Sanitary Corps, U. S. A.

Whitwell, E. Capt., General Service Staff, British War Office, Robert Treat Hotel, Newark, N. J.

Wickersham, John H. Maj., Engineers, U. S. A., P. O. 706, A. E. F., France.

Widdicombe, R. A. Maj., Engineers, U. S. A.

Widdicombe, Stacey H. U. S. S. M. A., Princeton, N. J.

Wiggin, Thomas H. Capt., Engineers, U. S. A., Headquarters, Lines of Communications, A. E. F., France.

Wiggins, Ralph Raymond. 1st Lieut., Aviation - Section, Signal Corps, U. S. A.

Wilcox, Ernest Hardwick. Capt., Engineers, U. S. A., 543d Engrs., A. E. F., France.

Wild, H. J. Maj., Engineers, U. S. A.

Wildish, Frederic Newton. Capt., Engineers, U. S. A., Co. B, 309th Engrs.

Wilgus, H. S. Maj., Engineers, U. S. A.

Wilgus, W. J. Col., Engineers, U. S. A., A. E. F., France.

Willard, George T. Private, Co. E, 318th Engrs.

Willard, N. R. Capt., Engineers, U. S. A.

Willcomb, George E. Capt., Quartermaster Corps, U. S. A.

Williams, Alan F. 2d Lieut., Co. B, 18th Engrs. (Ry.), U. S. Army P. O. No. 705, A. E. F., France.

Williams, Samuel W. Maj., Engineers, U. S. A.

Williamson, Harry. Capt., Royal Engrs.; O. C. 272d Ry. Constr. Co., R. E., E. E. F., Egypt.

Williamson, Lee H. 2d Lieut., Engineers, U. S. A., Co. A, 55th Engrs.

Williamson, Sydney B. Lt.-Col., Engineers, U. S. A.

Williar, Harry D., Jr. 1st Lieut., U. S. A., 1st Engrs., A. E. F., France.

Willis, Walter John. Lieut. (EDO).

Wilson, Edbert C. Capt., Engineers, U. S. A.

Wilson, Everitt W. Capt., Engineers, U. S. A., Co. A, 304th Engrs.

Wilson, Harry P. Capt., Engineers, U. S. A., 310th Engrs.

Wilson, Norman K. 2d Lieut., 473d Aero Squadron, Care, U. S. Air Service, 35 Eaton Pl., London, England.

Wilson, Robert B. M. Capt., Engineers, U. S. A., 311th Engrs.

Wilson, William R. Maj., 23d Field Co., R. E., B. E. F., France.

Wing, Charles B. Maj., Engineers, U. S. A., 23d Engrs., A. P. O. 738, A. E. F., France.

Winn, Walter E. Lt.-Col., Engineers, U. S. A., 114th Engrs., A. E. F., France.

Winn, Walter S. Maj., Engineers, U. S. A.

Winton, Walter Ferrell. Capt., Field Artillery, U. S. A., 14th F. A.

Wood, B. Russell. Capt., Engineers, U. S. A. (*Unassigned*). U. S. M. P. O. 733, A. E. F., France.

Wood, Frederic J. Maj., Engineers, U. S. A.

Woodard, Wilkie. Capt., Engineers, U. S. A., Co. H, 35th Engrs., A. P. O. 735, A. E. F., France.

Woodle, Bernon Tisdale. Capt., Engineers, U. S. A.

Woodruff, Glenn B. 1st Lieut., Engineers, U. S. A.

Woolworth, W. H. Capt., U. S. A., Headquarters, 2d Brigade, 1st Div., A. E. F., France.

Wooten, William P. Maj., Engineers, U. S. A.

Wright, John Bertram. Capt., Engineers, U. S. A.

Wrightson, William D. Maj., Sanitary Corps, U. S A.; Chf. of San. Corps, U. S. A.

Yates, Sheldon S. Field Artillery Officers' Training Camp, Camp Zachary Taylor, Ky.

Yeo, W. H. W. Capt., Engineers, U. S. A.

Yereance, Alex. W. 1st Lieut., Co. F, 305th Engrs., A. E. F., France.

Yost, Howard McC. Capt., Engineers, U. S. A.

Young, Frederick C. Capt., Engineers, U. S. A.; Adjt., 114th Engrs.

Young, George S. Capt., Engineers, U. S A.

Young, Samuel M. Capt., Engineers, U. S. A.

Zinn, George A. Col., Engineers, U. S. A.

MEMBERSHIP

(From September 6th to October 3d, 1918)

ADDITIONS

MEMBERS		Date of Membership.
Biles, George Herbert. Acting Chf. Engr., State Highway Dept., Harrisburg, Pa.	Assoc. M. M.	Aug. 31, 1915 Sept. 10, 1918
Carpenter, Frederick W. Lock Box 307, Cornwall, N. Y.		May 13, 1918
Clinton, Delmar Smith. Maj., Engineers, U. S. A., Constr. Div., 7th and B Sts., S. W., Washington, D. C.	Assoc. M. M.	Jan. 15, 1917 Sept. 10, 1918
Eager, Vernon Milton. Capt., Quartermasters Corps, U. S. A.; Asst. Superv. Const. Q. M., Terminals and Warehouses, Const. Branch of Constr. Div., War Dept., 7th and B Sts., Room 2-318, Bldg. C, Washington, D. C.	Assoc. M. M.	June 24, 1914 Sept. 10, 1918
Glenn, Russell Verstille. Senior Highway Engr., U. S. Dept. of Agriculture, Office of Public Roads and Rural Eng., 501 Wheat Bldg., Fort Worth, Tex.	Assoc. M. M.	June 3, 1915 Sept. 10, 1918
Goedecke, William. Chf. Draftsman and Chf. Engr., Guarantee Constr. Co., 140 Cedar St., Room 801, New York City		Sept. 10, 1918
Hill, Philip Brockett. (Lund & Hill), 527 Southern Trust Bldg., Little Rock, Ark.	Assoc. M. M.	April 30, 1912 Sept. 10, 1918
Kleinschmidt, Henry Schwing. Capt., U. S. A.; Address, 1308 Walker Bank Bldg., Salt Lake City, Utah	Jun. Assoc. M. M.	Mar. 1, 1904 Dec. 1, 1908 April 17, 1918
Moore, Charles Rea. Chf. Engr., Spokane Val. & North. Ry.; Chf. Engr., Am. Mineral Production Co., Valley, Wash.	Assoc. M. M.	Sept. 3, 1913 Sept. 10, 1918
Newhall, Henry Lester. Prin. Asst. to Chf. Engr., Water-Works Impvt., 102 East Mill St., Akron, Ohio	Assoc. M. M.	Feb. 28, 1911 Sept. 10, 1918
Passel, Howard Fay. Chf. Engr., C., I. & West. R. R., 115 Drexel Ave., Indianapolis, Ind.		Sept. 10, 1918
Perry, John Prince Hazen. Mgr., Contr. Dept., Turner Constr. Co., 244 Madison Ave., New York City	Jun. Assoc. M. M.	Nov. 1, 1904 May 28, 1912 Sept. 10, 1918
Rightor, Fred Elmer. Dist. Mgr., Texas Bitulithic Co., Austin, Tex.	Assoc. M. M.	May 31, 1910 Sept. 10, 1918
Smith, Bernhard Alexander. Civ. and Hydr. Engr., 352 Collins St., Melbourne, Victoria, Australia		June 18, 1918
Stuhrman, Edward Ahlert. Chf. Engr. of Design and Constr., for Arthur Tufts, 41 South Prado, Atlanta, Ga.		Sept. 10, 1918

MEMBERS (*Continued*)

		Date of Membership.
Taylor, Ernest William. Engr. in Sales Dept., The Brown Hoisting Machinery Co., 1094 East 99th St., Cleveland, Ohio		Sept. 10, 1918
Thomas, William Edward. Capt., Quartermaster Corps, U. S. A., Constr. Div., Camp Sevier, S. C.; Care, Commercial Bank, Charlotte, N. C.	Assoc. M. M.	July 1, 1909 Sept. 10, 1918
Tillson, Benjamin Franklin. Head. of Min. Dept., New Jersey Zinc Co., Franklin, N. J.		Sept. 10, 1918
Torkelson, Martin Wilhelm. Bridge Engr., Wisconsin Highway Comm., 2141 West Lawn Ave., Madison, Wis.	Assoc. M. M.	Sept. 12, 1916 Sept. 10, 1918
Trimble, Roswell Delmege. Cons. Engr., Winston & Co.; Res., 900 West Franklin St., Richmond, Va.		Sept. 10, 1918
Voynow, Constantine Borisson, Asst. Engr.-of-Way, Phil. Rap. Trans. Co., 820 Dauphin St., Philadelphia, Pa.	Assoc. M. M.	Sept. 7, 1904 Sept. 10, 1918
West, Wade Clarence. Capt., Engineers, U. S. A., Co. 5, E. O. T. S., Camp Humphreys, Va.	Assoc. M. M.	Sept. 3, 1913 June 19, 1918
Willard, Ernst Victor. Acting Chf. Engr., Minnesota State Drainage Comm., Old Capitol Bldg., St. Paul, Minn.	Assoc. M. M.	May 6, 1914 Sept. 10, 1918

ASSOCIATE MEMBERS

Ackhart, Andrew Lewis. Engr., Eastern Concrete Steel Co., 402 D. S. Morgan Bldg., Buffalo, N. Y.	Jun. Assoc. M.	Mar. 4, 1913 Sept. 10, 1918
Allen, Kenneth Bliss. 606 United Brethren Bldg., Dayton, Ohio		Sept. 10, 1918
Armstrong, Charles Chambers. Draftsman and Asst. Secy., Passaic Val. Sewerage Commrs., South River, N. J.		Sept. 10, 1918
Barzaghi, Arthur Jerome. Eng. Dept., Turner Constr. Co., Stamford, Conn.	Jun. Assoc. M.	Dec. 2, 1914 Sept. 10, 1918
Burton, Ansel Morris. Care, Standard Oil Co., Neodesha, Kans.		Mar. 12, 1918
Byrne, Thomas Sneed. Capt., Ordnance, U. S. A., U. S. Nitrate Plant No. 3, Toledo, Ohio		Sept. 10, 1918
Chapman, Stanley Alba. 1st Lieut., Co. C, 42d Engrs.; Address, 527 East Washington St., Pasadena, Cal.		May 13, 1918
Collier, Nelson Martin. Fairbury, Nebr.		April 16, 1918
Collins, Merton Clyde. 1st Lieut., Co. 5, E. O. T. S., Camp Humphreys, Va.; Address, 201 South Ogden St., Denver, Colo.	Jun. Assoc. M.	Sept. 3, 1913 June 18, 1918

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Cronemeyer, John Frederick William. Care, G. A. Spalding, 130 North Fairmont Ave., Pittsburgh, Pa.		Sept. 10, 1918
Fitzmaurice, Edmund Joseph. Engr., Ballinger & Perrot, 5821 Pine St., Philadelphia, Pa.		Mar. 12, 1918
Fulton, Clifford Robert. Engr. (Grant & Fulton), 2032 Worthington Ave., Lincoln, Nebr.		Sept. 10, 1918
Green, Nathaniel Warren. Care, A. Bentley & Sons Co., Jacksonville, Fla.	Jun. Assoc. M.	Dec. 5, 1911 Sept. 10, 1918
Gregory, Whitney Irwin. Chf. Draftsman, U. S. Engr. Office, P. O. Box 72, Louisville, Ky.	Jun. Assoc. M.	Sept. 3, 1913 Mar. 12, 1918
Hall, Roy Frank. Div. Engr., New York State Highway Comm., Utica, N. Y.		Sept. 10, 1918
Harrington, John Allan. Engr., Edward E. Gillen Co., 733 Wells Bldg., Milwaukee, Wis.		Sept. 10, 1918
Harvey, James Carothers. Dist. Engr. with James A. French, State Highway Engr., Los Lunas, N. Mex.		Sept. 10, 1918
Hawkins, George Lockwood. Pres., Almion Eng. & Contr. Co., 644 Westfield Ave., Elizabeth, N. J.		April 16, 1918
Hoerner, Charles Gottlob, Jr. Asst. Engr., New York Board of Water Supply, Phoenicia, N. Y.		Sept. 10, 1918
Holley, Harold Fiske. Dist. Engr., State Highway Dept., Carson City, Nev.	Jun. Assoc. M.	Aug. 31, 1915 Sept. 10, 1918
Horne, Ralph Warren. Asst. Engr., Fay, Spofford & Thorndike, 90 Ashland St., Malden, Mass.		Sept. 10, 1918
Hyman, Harry Abe. Pres., The Waterproofing & Constr. Co., Inc., 50 East 42d St., New York City		Sept. 10, 1918
Irving, James Norman. Asst. Engr., Quinton, Code & Hill, R. F. D. No. 3, Riverside, Cal.		Sept. 10, 1918
Kehoe, Alfred Lawrence, Jr. In Chg., Designing Dept., H. G. Balcom, 10 East 47th St. (Res., 605 West 182d St.), New York City		Sept. 10, 1918
Killion, Louis John. Engr., Monks & Johnson, 1825 Wylie St., Philadelphia, Pa.		Sept. 10, 1918
King, Thomas Richard. 1st Lieut., 116th Engrs., A. P. O. 733, Am. Exp. Forces, France (Res., 500 South Orange St., Glendale, Cal.)	Jun. Assoc. M.	April 16, 1918 Sept. 10, 1918
Kraus, Arthur. Leading Draftsman and Chf. Estimator, Public Works Dept., Brooklyn Navy Yard, 508 East 89th St., New York City	Jun. Assoc. M.	Mar. 5, 1912 Sept. 10, 1918
McNaughton, William Carlton. Acting Res. Engr., Rapid Transit Subway Constr. Co., 52 Ogden Ave., West Englewood, N. J.		Sept. 10, 1918

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	Date of Membership.
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Plew, William Reece. Prof. of Civ. and Architectural Eng., Univ. of Montana, 1004 South Central Ave., Bozeman, Mont	Sept. 10, 1918
Quinney, Elwin Harris. Deputy State Engr., Pierre, S. Dak.	Sept. 10, 1918
Reed, Charles Alley. Office Engr., Eng. Dept., City of Oakland, 4326 Montgomery St., Oakland, Cal	Sept. 10, 1918
Rollo, Ralph Alexander. City Engr., 2121 Division St., Murphysboro, Ill	Sept. 10, 1918
Ross, Lloyd McCreight. 202 North Brevard St., Charlotte, N. C.	Sept. 10, 1918
Ryder, John Marvin. Archt., Ground and Bldgs. Dept., Gen. Elec. Co., 16 Swan St., Schenectady, N. Y	Sept. 10, 1918
Sprigg, Carroll Crawford. Pres., Gen. Contr. & Eng. Co., 29 Broadway, New York City	Sept. 10, 1918
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Swecker, Cleophus. Div. Engr., State Road Comm., 5th Div., Century, W. Va	Sept. 10, 1918
Vestal, William Baxter. Secy. and Gen. Mgr., Clarkson Mfg. Co., Spokane, Wash	June 18, 1918
Wefel, Walther John. Chf. Draftsman and Designer, Ernest M. George, 1900 Euclid Bldg., Cleveland, Ohio.	Sept. 10, 1918
Witten, Donald. Cons. Engr. (Wood, Elston & Witten), 207 Wright Laboratory Bldg., Tulsa, Okla	Sept. 10, 1918
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Hardecker, John Francis. Asst. Chf. Draftsman, U. S. Naval Aircraft Factory, Philadelphia, Pa.	Sept. 10, 1918
Picken, Marshall Woolley. 2588 Creston Ave., New York City.	Sept. 10, 1918
Shipman, William Davis. Draftsman, Penn. Lines W. of Pitts., 200 Belva St., Avalon, Pa.	Sept. 10, 1918
Wilson, Norman Kenneth. 2d Lieut., 473d Aero Squadron, Care, U. S. Air Service, 35 Eaton Pl., London, England; Address 6233 Ingleside Ave., Chicago, Ill.	Sept. 10, 1918

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DEATHS

ANNEAR, EDGAR HAROLD. Elected Associate Member, March 5th, 1912; died in service (Hoboken, N. J.), August 28th, 1918.

CREHORE, WILLIAM WILLIAMS. Elected Associate Member, April 4th, 1894; Member, September 3d, 1902; died September 13th, 1918.

PEYTON, JOHN HOWE. Elected Member, June 1st, 1909; died September 14th, 1918.

SEE, GEORGE CORLISS. Elected Junior, September 3d, 1907; Associate Member, September 2d, 1914; died August 28th, 1918.

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(September 1st to September 21st, 1918)

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LIST OF PUBLICATIONS

In the subjoined list of articles, references are given by the number prefixed to each journal in this list:

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(3) *Journal,* Franklin Inst., Philadelphia, Pa., 50c.
(4) *Journal,* Western Soc. of Engrs., Chicago, Ill., 50c.
(5) *Journal,* Eng. Inst. of Canada, Montreal, Que., Canada.
(6) *Journal,* Am. Inst. of Archts., Washington, D. C., 50c.
(8) *Stevens Indicator,* Hoboken, N. J., 50c.
(9) *Industrial Management,* New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, 432 Fourth Ave., New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News-Record,* New York City, 15c.
(15) *Railway Age,* New York City, 15c.
(16) *Engineering and Mining Journal,* New York City, 15c.
(17) *Electric Railway Journal,* New York City, 10c.
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(20) *Iron Age,* New York City, 20c.
(21) *Railway Engineer,* London, England, 1s. 2d.
(22) *Iron and Coal Trades Review,* London, England, 6d.
(24) *American Gas Engineering Journal,* New York City, 10c.
(25) *Railway Mechanical Engineer,* New York City, 20c.
(26) *Electrical Review,* London, England, 4d.
(27) *Electrical World,* New York City, 10c.
(28) *Journal,* New England Water-Works Assoc., Boston, Mass., $1.
(29) *Journal,* Royal Society of Arts, London, England, 6d.
(32) *Mémoires et Compte Rendu des Travaux,* Soc. Ing. Civ. de France, Paris, France.
(33) *Le Génie Civil,* Paris, France, 1 fr.
(36) *Cornell Civil Engineer,* Ithaca, N. Y.
(42) *Proceedings,* Am. Inst. Elec. Engrs., New York City, $1.
(43) *Annales des Ponts et Chaussées,* Paris, France.
(45) *Coal Age,* New York City, 10c.
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(54) *Transactions,* Am. Soc. C. E., New York City, $12.
(55) *Transactions,* Am. Soc. M. E., New York City, $10.
(56) *Transactions,* Am. Inst. Min. Engrs., New York City, $6.
(57) *Colliery Guardian,* London, England, 5d.
(58) *Proceedings,* Engrs.' Soc. W. Pa., 2511 Oliver Bldg., Pittsburgh, Pa., 50c.
(59) *Proceedings,* American Water-Works Assoc., Troy, N. Y.
(60) *Municipal and County Engineering,* Indianapolis, Ind., 25c.
(61) *Proceedings,* Western Railway Club, 225 Dearborn St., Chicago, Ill., 25c.
(62) *American Drop Forger,* Thaw Bldg., Pittsburgh, Pa., 10c.
(63) *Minutes of Proceedings,* Inst. C. E., London, England.
(64) *Power,* New York City, 5c.
(65) *Official Proceedings,* New York Railroad Club, Brooklyn, N. Y., 15c.
(66) *Gas Journal,* London, England, 6d.
(67) *Cement and Engineering News,* Chicago, Ill., 25c.
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(71*a*) *Carnegie Scholarship Memoirs,* Iron and Steel Inst., London, England.
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(73) *Electrician,* London, England, 18c.
(74) *Transactions,* Inst. of Min. and Metal., London, England.
(75) *Proceedings,* Inst. of Mech. Engrs., London, England.
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(89) *Proceedings*, Am. Soc. for Testing Materials, Philadelphia, Pa., $5.
(90) *Transactions*, Inst. of Naval Archts., London, England.
(91) *Transactions*, Soc. of Naval Archts. and Marine Engrs., New York City.
(92) *Bulletin*, Soc. d'Encouragement pour l'Industrie Nationale, Paris, France.
(93) *Revue de Mètallurgie*, Paris, France, 4 fr. 50.
(96) *Canadian Engineer*, Toronto, Ont., Canada, 10c.
(98) *Journal*, Engrs. Soc. Pa., Harrisburg, Pa., 30c.
(99) *Proceedings*, Am. Soc. of Municipal Improvements, New York City, $2.
(100) *Professional Memoirs*, Corps of Engrs., U. S. A., Washington, D. C., 50c.
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(109) *Journal*, Boston Soc. C. E., Boston, Mass., 50c.
(110) *Journal*, Am. Concrete Inst., Philadelphia, Pa., 50c.
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(114) *Journal*, Institution of Municipal and County Engineers, London, England, 1s. 6d.
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(116) *Blast Furnace and Steel Plant*, Pittsburgh, Pa., 15c.
(117) *Engineering and Cement World*, Chicago, Ill.
(118) *Times Engineering Supplement*, London, England, 2d.

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The Reconstruction of Carmarthen Bridge, with Particular Reference to the Cylinder-Sinking under Compressed Air. Henry Stuart Beville Whitley. (63) Vol. 204, 1917.
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Standard Practice in Concrete Bridge Construction.* H. Colin Campbell. (117) Sept. 15.
Skew Subway Bridges Require Special Design.* (13) Sept. 19.
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Note sur l'Arche d'Essai de Melun en Béton à Fermettes Enrobées.* Frontard. (43) Jan.
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Electrical.

The New Electric Power-House at Birchills, Walsall.* Ernest Matthew Lacey. (63) Vol. 204, 1917.
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Calculation of Commutators of Alternating-Current Machines.* M. Schenkel. (Abstract from *Elektrotechnische Zeitschrift.*) (73) June 14.
On the Temperature Variation of the Electrical Conductivity of Mica.* H. H. Poole. (Abstract from *Philosophical Magazine.*) (73) June 14.
Some Transient Phenomena in Electrical Supply Systems.* E. W. Marchant. (77) July.
The Mechanical Design and Specification of the Turbo-Alternator Rotor. (77) July.
Charging Currents and Earthing Devices in Transmission Lines.* H. Behrend. (73) July 12.
Electrification of Steam Driven Three-High Merchant Mill at the Frodingham Iron and Steel Works.* (73) Aug. 2.
Synchronizing of Alternators.* E. Styff. (Abstract from *Elektrotechnische Zeitschrift.*) (73) Aug. 2.
Automatic Telephones at Australia House, London.* (73) Aug. 9.
Mining Electrical Engineering. Chris. Jones. (Abstract of paper read before South Wales Inst. of Engrs.) (26) Serial beginning Aug. 9.
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Some Notes on Public Fire-Alarm Systems. G. W. Stubbings. (26) Aug. 23.
The Port Elizabeth Electricity Works, South Africa.* (26) Aug. 23.
Turbine House Plant Operation. T. G. Otley. (Abstract of paper read before South African Inst. of Elec. Engrs.) (26) Aug. 30.

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* Illustrated.

Electrical—(Continued).

Some Points Regarding Calorimeter Efficiency. Walter P. White. (3) Sept.
Application of Harmonic Analysis to the Theory of Synchronous Machines.* Walter U. Lyon. (42) Sept.
Economic Proportion of Hydroelectric and Steam Power.* Frank G. Baum. (42) Sept.
Critical Review of the Bibliography on Unbalanced Magnetic Pull in Dynamo-Electric Machines.* Alexander Gray and J. G. Pertsch. (42) Sept.
Current Transformer Ratio and Phase Error by Test Ring Method.* H. S. Baker. (42) Sept.
Magnetic Pull in Electric Machines.* E. Rosenberg. (42) Sept.
The Magnetic Permeability of Steel.* Frank P. Fahy. (105) Sept. 1.
Methods of Insulating A. C. Generator Coils.* H. D. Stephens. (64) Sept. 3.
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The Ventilation of Turbo-Generators.* J. Humphrey. (22) Sept. 6.
Graphical Methods for Resistances in Parallel.* W. T. Maccall. (26) Sept. 6.
New Plant of the Pennsylvania Salt Manufacturing Plant.* (64) Sept. 17.
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How to Buy Direct-Current General Utility Motors.* A. Brunt. (72) Sept. 19.
Some Practical Points in Pole and Tower Erection and Support.* Charles R. Harte. (17) Sept. 21.
Diagnosing and Correcting the Causes of Low Vacuum. Hartley Le H. Smith. (17) Sept. 21.
La Reconstitution de la Belgique au Point de Vue Electrique; Projet de Mise en Commun des Production d'Electricité. J. Carlier. (33) Aug. 10.
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Les Projections Cinématographiques au Moyen de Lampes à Incandescence.* (33) Aug. 24.

Marine.

Evolution of Electric Welding Processes as Applied in Shipbuilding. H. A. Horner. (115) July.
Concrete Ships. Harvey S. Owen. (115) July.
Electrically Welded Cargo Ships. (115) July.
Concrete Ships. (118) Serial beginning Aug.
Application of Electric Welding to Shipbuilding. (11) Aug. 23.
Construction of Concrete Ships for Emergency Fleet Corporation. R. J. Wig. (Abstract from Report made to U. S. Shipping Board). (96) Aug. 29.
Tools for Electric Welding.* (Shipbuilding.) W. L. Merrill. (2) Sept.
Nomenclature for Electric Welding.* (Shipbuilding.) H. G. Knox. (2) Sept.
Early History of the Marine Torpedo.* H. H. Manchester. (72) Sept. 5.
Manufacturing Eagles at Ford Shipyard.* Chas Lundberg. (20) Sept. 19.
Les Bateaux en Béton Armé aux Etats-Unis.* (33) Aug. 17.
Schiff aus Eisenbeton.* (107) June 29.

Mechanical.

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THE ECONOMICS OF STEEL ARCH BRIDGES

Discussion*

By Messrs. H. S. Sales and David A. Molitor.

H. S. Sales,† Esq. (by letter).‡—It would be difficult to over-estimate the value of the information given in this paper. To the engineer who is first confronted with the problem of designing a steel arch, innumerable difficulties present themselves; and these have to be studied and solved *ab initio.* In a country like India, where steel arch bridges are seldom, if ever, used, it is unlikely that the engineer will be able to obtain much assistance in designing one, either by the advice of his colleagues, or by reference to recorded experience. One of the first questions he will ask is whether or not his preliminary layout is economical. It would be impossible to arrive at a decision on this vital point unless he had at his disposal sufficient time to work out a considerable number of skeleton designs, which is extremely unlikely. The labor involved can be better imagined than described in detail, as it is well known that arch calculations, compared with simple truss calculations, are extremely intricate; and it requires considerable practice to gain any facility in the work. With the aid of Dr. Waddell's notes and charts, the engineer's labors, however, will be lightened considerably, and, in fact, to such an extent that he will be able to begin the detailed design of an arch bridge systematically, provided he has had experience in steel structural work, and has a few type designs representing modern practice to which he can refer. Dr. Waddell remarks: Mr. Sales.

> "Occasionally, an American bridge engineer builds a steel-arch structure; but usually simple-truss spans are adopted because their approximate weights and their economics are on record."

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* Discussion of the paper by J. A. L. Waddell, M. Am. Soc. C. E., continued from September, 1918, *Proceedings.*

† Bridge Engr., North-Western Ry. (State), Simla, India.

‡ Received by the Secretary, September 14th, 1918.

Mr. Sales. If this applies to America, it may be supposed that the same conditions prevail in India. The reason is obviously due to the circumstances under which engineers in India are necessarily placed. As mentioned previously, the beginning of steel arch design, leaving out the question of experience, necessitates an amount of study and time which the engineer cannot usually devote to the subject. Most engineers realize this, and would not willingly accept the task of designing an arch bridge unless sufficient time was available for carrying out the preliminary work thoroughly and systematically. Any information, therefore, which will result in a reduction of labor connected with the complicated preliminary calculations will be most gratefully received, and the thanks of the Profession in India are due to the author for his valuable paper, and the assistance which is to be derived by studying it.

The economy of steel arch bridges is established beyond question. The price of steel has gone up by leaps and bounds, and it may be safely assumed that finished structural steelwork cannot, in the near future, be obtained for much under Rs. 300 per ton. Within the next few years, therefore, it is reasonable to suppose that proposals may be put forward for steel arch bridges, when conditions justify their use. It is much to be regretted that space could not be found to publish with the paper the graphic calculations of stresses, diagrams of stresses and sections, and tabulated estimates of metal, etc. The information would be valuable and instructive as examples of preliminary calculations and designs for reference. As an instance in support of this statement, take the extreme case of a hingeless steel arch: The estimation of the stresses in structures of this kind is anything but straightforward work, except, perhaps, by experts. Quantities have to be assumed tentatively, as, for example, the moment of inertia of the rib at various points. Hence correct judgment plays a very important part in the preliminary investigations; and, without it, the uninitiated is likely to waste a lot of time before he begins the actual design of the structure. Also, it is beyond question that the expert discovers for himself methods by which close approximations can be made, thus reducing to a minimum the trial-and-error part of the work. It is probable that the unpublished matter contains many shortcuts of the kind just mentioned, and that the paper would be more valuable if this part of the investigation work had been included.

The writer thinks that few experts in the design of steel arch bridges are to be found in India. The author himself draws attention to the need for special knowledge of this branch of bridge engineering, and even goes so far as to say that comparatively few structures of this kind have been built in America. There are certainly very few, if any, steel arch railway bridges in India. It would seem, therefore, that the author has undertaken the task of educating engineers in this particular branch of the profession; and the writer regards

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this paper as a successful effort in this direction. His only regret is that it could easily have been more complete. Nevertheless, it is hoped that, judging by past experience, the author will find time to write a treatise on arch bridges, and include in it all the diagrams and preliminary work for which space could not be found in his paper. These remarks lead to the consideration of an aspect of steel arch bridge design which, in the early days, was considerably neglected, but which, nevertheless, now seems to be receiving the attention it deserves. The writer refers to the peculiar knowledge possessed by the expert, namely, that which is concerned with the possible lines on which steel arch bridges can develop by alteration of type or shape of structure. The important question which he so frequently asks himself is: Is bridge design wholly science; or should it be largely an art? An enthusiast in any constructive science, the engineer included, will use all the means at his disposal to effect his object, whether these means consist in mechanical skill or the application of mathematical knowledge. In steel bridgework both are essential, and perhaps in some work, notably the arch bridge, mathematics plays the most important part. Unfortunately, mathematics is regarded by many as the beginning and end of all bridge design; so that many engineers have, at last, been deterred from advancing on certain lines of progress because they felt that they could not undertake the enormous amount of computation work necessary before the actual scheming could be put in hand. To these the actual design had necessarily to occupy a secondary place which could not be approached without the mathematical knowledge required to complete the preliminary work. If, therefore, the mathematics of steel arch bridges can be presented in such a way that it constitutes a well-made tool from which further operations can begin, then the engineer is at once raised to a new level, and a strong inducement is provided for him to undertake work which, otherwise, he might not be able, or inclined, to begin. The greatest thanks of the Profession, therefore, are due to those who, like Dr. Waddell, have presented their mathematical work in tabular or graphic form suitable for general use. By doing so the mathematical part of the work has been reduced from a problem to a process, with the result that the engineer can devote more of his energies to that part of his work which may be described as "constructive art."

Problem No. 1.—On page 424* the author mentions "the lateral system in a simple truss bridge." There would seem to be some uncertainty as to what is exactly meant by this expression. Truss bridges are of two kinds, deck and through; and the latter is provided with a floor system in addition to the lateral system proper. Is it to be understood that the weight of the lateral system plus rail-girders plus

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* *Proceedings*, Am. Soc. C. E., March, 1918.

Mr. Sales. cross-girders will offset that in the bracing of the floor system plus that of the rib flanges of the corresponding arch structure, plus that of the other diagonals between the arch ribs? Probably not; but the writer thinks that the fact might have been stated; or, what is still better, that the style of the structures in which the relative weights of parts are considered might be illustrated by clear diagrams. To bring Dr. Waddell's results into line with Indian conditions, much work will be necessary in connection with tabulating the weights of various types of spans designed for all gauges, and under different loadings.

The author refers to a very interesting point concerning a method for hinging the crown of two-hinged and three-hinged arches. His method is to hinge the crown at mid-depth for the dead-load stresses, and afterward to make both the upper and lower chords hingeless for the live-load stresses.

Problem No. 2.—The formula, $A = \dfrac{T + \dfrac{2\,M}{d}}{p_c}$, for the area of the chords, would seem to imply that the section will not be symmetrical about the neutral axis; and this, in fact, is what is found in the bottom raker struts and other principal members of certain cantilever spans where the top flanges are of greater area than the bottom ones. It would be interesting to know whether the contour of the arch rib can be placed so as to give symmetrical rib sections, and, if not, what rules are adopted to determine provisionally the position of the neutral axis.

The author frequently refers to the esthetic aspect of bridge design. His remarks lead one to regard esthetics as probably embodying economical principles hitherto unsuspected, except, perhaps, by experts. Whether mathematical considerations will eventually lead to true esthetics, or esthetics will indicate the true mathematical principles to be followed, are matters for speculation. It would be interesting to know what the author has to say on this subject. It would seem that the parabolic curve, so frequently adopted for the contours of arch ribs, is not a line of beauty, and that, under certain restricted conditions, arches might be reasonably made of circular form. The writer does not know whether this is generally possible, but thinks that the subject is worthy of investigation, as a slight increase in weight of metal might be compensated for by the better appearance of the bridge. Though there must be diversity of opinion on matters which are so often decided by individual taste and preference, yet the esthetics of bridges concerns every one, and, in such cases, guiding principles must be sought for, rather than an appeal made to what, after all, may be only traditional belief or sentiment.

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Problem No. 3.—The placing of a hinge in a spandrel-braced arch is a problem which has been solved by the author in a very interesting manner. He points out that the conditions in light bridges are such that top chords are provided with sections which are in excess of theoretical requirements. By placing the hinge in the top chord, the superfluous metal is utilized, and the total weight in arch metal is considerably reduced. These are principles of construction which, to some extent, apply to simple-truss spans. It would be interesting to know how Dr. Waddell would design the ordinary through type of truss span so that the top lateral bracing could be arranged to assist the top chords to the utmost extent by taking a part of the compression to which these members are subjected. There seem to be strong grounds for believing that it actually does perform this office.

Problem No. 4.—The writer notes the author's conclusion that the spandrel-braced arch is lighter than the braced-rib structure for a 200-ft. span, but a little heavier for the 500-ft. span. The author, however, does not inform the reader whether the comparisons are made with hingeless, two-hinged, or three-hinged arches. Perhaps the relative weights are the same for all three types; but the point might have been brought out in greater detail, and the part of the paper devoted to Problem No. 4 expanded considerably.

Problem No. 5.—The solution of Problem No. 5 is valuable. One of the first questions the bridge engineer will ask himself is: Is it justifiable to undertake an enormous amount of computation work to obtain stresses in a hingeless arch when perhaps, everything considered, the two-hinged or the three-hinged arch might, in the long run, be the most economical in metal and, from a practical point of view, be the best? The reader, doubtless, will be perplexed by the diversity of quoted opinions on the relative economics of the hingeless arch. One authority states that the hingeless is more economical than a two-hinged or a three-hinged arch; another that the three-hinged arch is the most economical; and still another that the hingeless type is more economical than the two-hinged and the three-hinged; and that the two-hinged is about as economical as the three-hinged. The whole question, however, turns largely on the rules used for allowances of metal for stresses of different kinds. Take the case, for example, of a truss continuous over two spans. Most engineers would consider that economy would be effected by making the span continuous; and yet the writer knows of a case where the spans considered singly were as strong as when considered as continuous. The ruling factor in this case was the extra allowance made under rules for the reversals of stress. Without that extra allowance the continuous girder would prove to be the most economical. Dr. Waddell finds that, if the extra effect of stress reversals is ignored, the hingeless and the two-hinged ribs will be lighter than the three-hinged ones; also, that, if the extra

Mr. Sales. effect of stress reversals is allowed for, there is not much to choose as regards economy in favor of the two-hinged type over the three-hinged; also, that, if the extra percentage to be allowed for reversals is 75% instead of 50%, as some engineers specify, the weights of the two-hinged and three-hinged types will be alike. The author also considers temperature stresses, and finds that, if they are provided for without increasing the working stresses, there will be a 7% advantage for the three-hinged type; but if, on the other hand, a 20% increase of intensities of stress is allowed for the combination of the stresses due to all loadings and temperature effects, then the two-hinged type, as far as weight of metal is concerned, has the advantage over the three-hinged type. These conclusions are exhibited in Table 6, from which it is found that, both for railway and highway bridges, the hingeless arch is the heaviest, the three-hinged arch comes next, and the two-hinged is the lightest.

Problem No. 6.—The author, in a few words, describes the economics which result from a combination of the two-hinged and three-hinged types, by which the structure is three-hinged for the dead loads and two-hinged for the live loads. The relative weight of this combination, compared with the three-hinged structure, is estimated at 97% of the latter in the case of railway arches, and 99% in the case of highway arches. The advantages of the combination type over the three-hinged type are: greater rigidity in the moving load, and less difficulty and expense in erection.

Problem No. 7.—This part of the paper should be of great interest to Indian engineers, and the two layouts given by the author will be much appreciated should the occasion arise when an arch bridge is contemplated for a site where satisfactory anchorages cannot be found, but where it is desirable to secure the economy of such a bridge with its beauty of structure. The layout for a cantilever arch bridge indicates the lines on which designs of bridges might, with advantage, be prepared to span some of the well-known openings similar to those on Indian railways in hilly country. In such cases it is often found that the gorge abruptly descends to a great depth at a distance, say, of 100 to 150 ft. from the bank, and good rock foundations can only be found at some considerable distance below, and away from the abutments. The bridge shown by Fig. 14 seems to be an ideal type for these conditions. A layout for an arch bridge, with flanking simple-truss spans is shown on Fig. 15. It would seem that this design is not so adaptable for Indian conditions as Fig. 14.

Problem No. 8.—The author remarks that the bridge engineers of America were unable to furnish reliable data relating to the ratios of weights of metal in arch bridges and truss spans. He, however, evolves three formulas which give percentages to be applied to weights of metal in trusses of simple-truss spans in order to find the weights

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for arch ribs and the superimposed columns with their bracing to carry the same live loads. Results obtained from the three formulas are plotted for steam-railway, electric-railway, and highway structures as diagrams on Fig. 16. For spans of less than 100 ft. the economy of the arch bridge is not so marked, and ranges, roughly, from 75 to 100% of the simple-truss span. For spans of 300 ft., however, the percentage lies between 63 and 82. The diagram is instructive and comprehensive. It may be pointed out, however, that only the extreme limits of the percentages for 100-ft. and 1 000-ft. spans were computed, and the middle one interpolated by judgment. Diagrams of weights of metal in single-track, steam-railway arch bridges of carbon steel under seven classes of loading are given on Fig. 17, and similar information for double-track bridges on Fig. 18. Weights of metal in highway arch bridges of carbon steel with paved roadway on reinforced concrete base, and reinforced concrete sidewalks, and carrying a double-track electric railway at the middle of the deck are furnished for five widths of deck on Fig. 19. Weights of metal in single-track and double-track steam-railway arch bridges have been computed for nickel steel, and the results exhibited on the diagrams shown on Figs. 20 and 21. All these diagrams are valuable; and, although absolute accuracy cannot be depended on, for the reasons stated by the author, yet they are in most cases sufficiently so to enable the engineer to frame comparative estimates and fix the dead loads of an arch structure before preparing his final stress sheet.

Mr. Molitor.

DAVID A. MOLITOR,* M. AM. SOC. C. E. (by letter).†—In this paper the author has presented, in very well arranged form, the conclusions deduced from an extensive set of calculations bearing on the economics of steel arch superstructures. As arch bridges have grown rapidly in popular favor, during recent years, in America, chiefly for esthetic reasons, such extensive investigations are both interesting and valuable. The findings, as recorded, though not always conclusive, will at least serve as a guide in designing, and will save others many unnecessary labors.

"The Economics of Steel Arch Bridges," of course, would include economic relations between superstructure and substructure costs in any given case, and, though not intending any adverse criticism because this phase of the subject was neglected, and necessarily so, as only generalities could be treated and the substructure always depends on special conditions, yet the paper does not cover all that is implied in its title.

The comparison between arch and simple truss superstructure weights is of limited value, because the cost ratio is generally reversed when the substructures are considered.

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* Detroit, Mich.

† Received by the Secretary, October 2d, 1918.

Mr Molitor. The fundamental problem in the economics of arch bridges consists in solving the conditions for economic span lengths for a given bridge profile comprising many spans. It might be supposed that any set of spans complying with the economic rise to span-length ratio would fulfill the requirements for a complete structure. In other words, any intermediate span would have a length of about four times its available rise. This would be true only for exceptionally favorable foundation conditions, for which the cost of piers and foundations might become relatively negligible. However, span lengths thus chosen would never result in maximum economy for end spans and for less favorable foundation conditions. Thus, the author's answer to his first problem is not conclusive, as he deals only with proportions of superstructure dimensions. His economic rise to span-length ratio, therefore, is correct only for a single span of the superstructure, as for a bridge spanning a rocky chasm where no expensive abutments are required.

Generally, however, the author's ratio must be increased until the resulting horizontal thrust is reduced to an amount where the cost of abutments attains a consistent minimum. This frequently leads to a ratio approaching 0.5, resulting in a small increase in cost of superstructure, which will be more than equalized by the saving thus accruing to the abutments, if it is a single span, or to the piers for an intermediate span.

Although such a high ratio is practicable, especially for stone and concrete arches, yet the shape of arch resulting therefrom is not always pleasing from the esthetic viewpoint, which so frequently interferes with economic considerations.

Hence, for all practical purposes, one might adopt the rule, that the rise-span ratio should be chosen so that it would produce the best general appearance for the least total cost of structure. This rule, probably for centuries, has received tacit acceptance without getting into print.

The author states that "in order to cover effectively the ordinary range of span lengths for arch designing, it was necessary to compute for three lengths." The writer wishes to point out that it requires more than three points to fix a curve or law, and even four points might prove inadequate for empiric laws of the kind here sought.

In solving Problem No. 2, the author's reasoning in finding the economic rib depth for braced-rib arches is not clear. He first explains that this question does not arise in the case of solid-rib arches, because the rib acts both as a beam and a strut, and then proceeds to apply the economic criterion of ordinary girders (whether solid or open-web) to the braced rib, which likewise resists bending and compression. The only difference is that open-web bracing carries shear only, while the chords or flanges receive direct stress from arch thrust. Hence, in neither case does there appear to be any justification for the assumption

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that the economic depth, d', is one for which the chord area, A_m, is equal to the web area, A_w (for live load only), even when the rib center line is properly located.

The suggestion of making the arch depth, at mid-span, equal to from 6 to 8% of the span length, for spandrel-braced arches (presumably three-hinged) seems to be contrary to economy; and the uniformity in chord sections, resulting from rib-depths proportional to the bending moments, is, in the writer's opinion, a decided economic advantage, both in weight and in design, which should not be disregarded.

It is strange that the author did not give more attention to the question of the economic shape of the arch center line, as even slight deviations affect the weight of superstructure very detrimentally, and any resulting increase in weight affects the cost of abutments and foundations. This, perhaps, is the most important general principle in arch economics, which has been shamefully disregarded in the past, though it more vitally affects concrete and masonry designs. Actually, the eight economic problems treated are more or less secondary in importance to the economic shape of the arch center line.

In his paper, "Three-Hinged Masonry Arches, Long Spans Especially Considered",* the writer showed that the center line of the arch ring should be the resultant polygon drawn for the full dead load plus one-half the uniformly distributed live load (including impact), acting over the entire span, to produce the maximum economy in material for the unsymmetric maximum and minimum live-load conditions.

The writer again discussed this economic feature in his treatise, "Kinetic Theory of Engineering Structures," on pages 305 and 323, and shows, further, on page 307, that an arch ring, formed to meet this condition, can never be truly circular or parabolic in shape. The resultant polygon becomes a circle when the superimposed load at the springing points, for semicircular rings, becomes infinite. This polygon becomes a parabola for an absolutely uniform load per foot of bridge. Neither case of loading can be realized in practice, though very flat arches closely approach the parabolic shape.

A very important result, obtained from a proper choice in the shape of the arch ring, is that all normal sections of the ring will be symmetric with respect to the axial line, or resultant polygon. A further economy in detailing will thus be accomplished, because the equal maximum bending moments (positive and negative) for each section will also have attained their smallest values for any given depth of ring.

Although this matter is most important when dealing with concrete and masonry arches, it remains a significant factor in the design of large metal arches, but may be neglected, for esthetic reasons, on small bridges.

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* *Transactions*, Am. Soc. C. E., Vol. XL (1898), p. 61.

Mr. Molitor.

The author is inclined to adopt the same economic rib depth for three-hinged, two-hinged, and hingeless arches, and then says that for large two-hinged arches, such as the Hell Gate Bridge, the depth should vary in proportion to the bending moment. He finally states that esthetics and rigidity should never be sacrificed for the sake of economy in weight of metal.

These several statements regarding the economic depth of arch rib, which are quite inconclusive and at variance with each other, might have been condensed into the simple rule—do as you please, or as you think best.

In considering Problem No. 3, which deals with the location of the crown-hinge of a three-hinged, spandrel-braced, arch in either the top or bottom chord, it would appear to be almost self-evident that less material would be required for the top chord hinge because the horizontal thrust is diminished by the greater rise resulting from this layout. The same circumstance would have an economic effect on the substructure or abutments. Hence, it is prudent to choose a minimum crown depth consistent with good details.

The conclusions found for Problem No. 4 are apparently correct, provided the bottom chord of the spandrel-braced arch is formed to meet the economic requirement for shape. The solid-rib arch is necessarily somewhat wasteful of metal, especially in the web, precisely as for simple plate girders. The braced rib having two compression chords of about equal sections will usually require more metal than the single bottom chord of the spandrel-braced arch, where the chord section is consolidated and the bending moments are carried by the spandrel bracing in direct stress.

Regarding Problem No. 5, the author's conclusions, on the relative economics of hingeless, two-hinged and three-hinged types, are, after all, based on a somewhat meager assortment of data, despite his labors expended toward its solution. In the first place, he did not give due consideration to the special advantages accruing to each type (as a time-saving expedient), and hence the weights found are not strictly comparable. The assumption of a single value of impact for all truss members is in itself sufficient to wipe out the comparatively small weight differences sought, as the loaded lengths governing the critical stresses in a member, similarly located in each type, is materially different, which may be shown by a comparison of the influence lines for the three cases.

Under such circumstances, it is not at all surprising that he found the economics of the three types depending almost entirely on the "method of treating reversing stresses, and the importance accorded to temperature stresses." This raises the pertinent question regarding the applicability of specifications to arch bridges, when such specifications were developed for simple truss bridges only. There are

Mr Molitor.

numerous inherent differences between arches and trusses not covered by the ordinary bridge specifications, and any one familiar with arch designing will realize that these differences will suffice to explain the disparity between the author's conclusions and the findings of others quoted in the paper.

The writer can see no justification for treating reversing stresses according to the author's specifications for truss bridges, as the two cases of stress are produced at different times, by widely different loadings (both in position and magnitude), and different impact, and, therefore, can have no simultaneous static effect on which to base the section of any one member. Furthermore, the formulas of Launhardt and Weyrauch, based on the experiments of Woehler and Bauschinger, furnish no justification for applying the principle of fatigue to the design of any bridge members, as is best shown by referring to the experiments themselves. On this point see "Fatigue of the Material."*

Hence, all that can reasonably be required is to design each member so that it will withstand safely its maximum and minimum conditions of stress, one at a time, without exceeding the allowable units of stress for each condition. Ordinary prudence would require some provision for a future increase in live load and still have a structure of uniform strength throughout, relatively to the elastic limit of the material. This can be accomplished by designing all web members, or those in which the total stress is not proportional to the total loading, for such augmented live loads on the basis of appropriately higher unit stresses, chosen so that the actual unit stresses shall exceed the allowable values in a constant ratio.

To make this clear, suppose the structure is to be made safe for 100% overload in live load only (which is extreme), then the D. L. + 2 (L. L. + *I*) stress in the chords may become, say, 1.6 times as great as for D. L. + L. L. + *I*, depending on the relative magnitude of D. L. to L. L. This would result in raising the allowable unit stress 1.6 times, or to, say, 80% of the elastic limit. Then, if the web system is designed for stresses resulting from this same overload, using unit stresses 1.6 times the allowable values, the structure will be of uniform strength throughout with respect to the elastic limit of the material, for live loads equal to twice those normally assumed. This is the writer's method of designing all structures, and puts the extra material where required to strengthen the weakest parts.

From theoretic considerations alone, the relative weights of metal, for the three types of arches, should be approximately as given by Malverd A. Howe, M. Am. Soc. C. E., quoted on page 439.† However, local conditions and practical reasons frequently preclude the possibility of adopting the most economic type (the hingeless), especially

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* "Kinetic Theory of Engineering Structures", p. 265.

† *Proceedings*, Am. Soc. C. E., March, 1918.

Mr. Molitor. for long-span bridges. Also, as pointed out before, the weight of superstructure alone, does not usually decide the economic status, so that each case will still require investigation for the conditions peculiar to the site. The rise-span ratio, also, has an important bearing on this problem, and may be a determining factor, especially for large half-through arches like the Hell Gate Bridge.

The conclusion to Problem No. 6, leaves no room for comment, as the larger variables are here eliminated and the answer becomes more or less obvious.

The cantilever arch bridge, which received attention in Problem No. 7, represents a type which has not been fully appreciated, though its application is somewhat limited; but, where the profile and foundation conditions fit such a layout, there is certainly every argument in favor of a two-hinged cantilever arch. The stress calculations offer no special difficulties, provided influence lines are used. Any other method of calculation might prove hazardous on account of the complicated load positions for critical stresses. The author's findings relative to the proportions of span lengths are very valuable.

It should be mentioned that a three-hinged cantilever combination is usually undesirable, and may possibly result in unstable forms.

The final weight curves, presented under Problem No. 8, for arch superstructures, constitute a valuable contribution to our meager knowledge of this subject. These curves will at least save the labor of a preliminary weight calculation in most cases, thus permitting the designer to proceed at once to a fairly comprehensive stress analysis.

Exception might be taken to the author's reasoning applied in finding the maximum possible span length for three-hinged arches. He makes W_a infinite and finds the corresponding span length, $l = 3\,540$ ft.; but W_a is the weight of metal per linear foot of span, and when this is infinite, the dead-load stresses in all principal members become infinite. This is evidently not an answer to the question of what span length will result in such a dead load that the unit dead-load stresses in the members will not exceed the maximum allowable values normally assigned for total dead plus live load. Even this span length, if known, would exceed all limits of usefulness, as a bridge of this span could carry no live load.

The other assumption: "that the said limit is reached when it takes 4½ lb. of metal to carry 1 lb. of live load," leads to a very much shorter span, which the author estimates at about 2 000 ft., though this would lead to an enormously expensive bridge.

The author's opinion "that if more were known generally concerning the weights of metal in steel-arch structures, their economic functions, and their comparative economy in respect to the corresponding simple-truss structures, the esthetic type would be adopted more frequently, in spite of the greater labor it involves in both designing and con-

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struction," does not appear as a real excuse for not adopting the arch type whenever that type is warranted.

In the first place, the weight data referred to are merely a convenience and, if unknown, do not constitute a deterrent factor to any one of earnest endeavor, as is manifested by the numerous steel arches designed in the past. Then, also, the greater labor involved in designing arches depends very much on an appropriate choice of the methods used, and on the competency and experience of the designer; but the greatest obstacle to popularizing arches is, perhaps, the personal bias frequently expressed against this type by bridge engineers themselves, owing largely to a limited familiarity with this more specialized branch of bridge engineering.

In fact, the author himself has frequently expressed his views adversely to all structures involving redundancy, and his present effort may be accepted to indicate that he is gradually changing his views on this subject.

It is the writer's opinion that arches of steel, concrete, or reinforced concrete, should receive the first consideration, whenever the profile, site, and foundation conditions warrant their construction, regardless of any lack of preliminary weight data, or the slightly greater labor involved in their design. In thus minimizing the difficulties and expenses attending such designs, he is actuated by the results of his own experience, with the general comprehensive methods (mostly graphic), presented and advocated in his recent treatise previously referred to, and which can be more fully appreciated by any one who will approach the subject with an open mind. That many bridge engineers have neglected to post themselves, is manifested by articles in current literature and professional papers, where cumbersome and obsolete methods are often presented as new and novel.

The author deserves much credit for his present contribution on arch economics, a subject about which little has been published. The paper points the way to accomplishing more in this direction, and emphasizes the importance which the designer should give to economic studies.

AMERICAN SOCIETY OF CIVIL ENGINEERS
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PAPERS AND DISCUSSIONS

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DETERMINATION OF THE DUTY OF WATER BY ANALYTICAL EXPERIMENT

Discussion.*

By J. C. Stevens, M. Am. Soc. C. E.

Mr. Stevens.

J. C. Stevens,† M. Am. Soc. C. E. (by letter.)‡—The author defines the duty of water, as used in his paper, to be "the quantity which can be applied with the greatest efficiency, under given conditions, for the production of crops."

It appears to the writer that the author's study merely resolves the quantity of water applied in practice into its component parts, without touching on the matter of efficiency at all.

Doubtless, the author concludes that the duty given is the efficient one, the data forming the basis of his conclusion being withheld for the very excellent reasons given in his closing paragraph.

The total quantity necessary for the crops in question, and its component parts, in the terms used by the author, are given in Table 13. To these quantities must be added the losses incident to the transportation of the water to the point of use, and storage losses, if any. Hence, the duty given in Table 13 appears to be very low indeed.

TABLE 13.

Component.	Harney Valley.	Chewaucau Marsh.
(1) Soil Moisture	14.0 inches.	12.2 inches.
(2) Soil Evaporation	10.8 "	10.5 "
(3) Plant Use	8.0 "	14.5 "
(4) Soil Losses	24.0 "	23.0 "
Totals	56.8 inches.	60.2 inches.
Acre-feet per acre	4.73	5.00

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* Discussion of the paper by W. C. Hammatt, M. Am. Soc. C. E., continued from April, 1918, *Proceedings*.

† Portland, Ore.

‡ Received by the Secretary, September 16th, 1918.

Mr. Stevens.

Good yields of alfalfa, wherever the climatic conditions favor its growth, can usually be secured with about half the foregoing quantities, net on the land. Moreover, alfalfa is generally conceded to require more water than any other general crop growth in the United States.

The questions naturally arise: Is the land thus situated, where the total water supplies are limited, being put to its highest use? Would it not be far better to put twice the area under cultivation with the same water supply?

It is seen that the largest single component of the water duty is "Soil Losses". This is treated under the caption "Percolation and Run-off" from which it appears that these particular grasses require flowing water during the growing period, in order to produce aeration and carry off the alkaline salts.

The author states that, in Harney Valley, except for the sugar grass areas, continuous surface flooding is required in order to avoid alkalinity, and not for plant growth. In other localities the accepted method of removing injurious alkaline salts is by drainage. If open ditch drainage will obviate the necessity of continuous flooding, is not that the first point of attack, in order to determine the efficient use of water in this locality?

The writer knows the two areas in question only by reputation and cursory examination. He knows that in both valleys there are large areas of land and small quantities of water, and it would seem that the only justifiable use of the limited water supply is one that will put the greatest number of acres under cultivation and create the greatest number of homes.

The writer awaits with interest the remaining data which the author undoubtedly has obtained. For example, it would be interesting, indeed, to know the total quantity of water consumed in the two valleys during the two seasons in question. On Chewaucan Marsh this could have been, and perhaps was, determined with ease by measuring the total inflow and outflow on the upper and lower marshes at the three constricted portions of the valley. This consumption should be comparable with the sum of the first three component parts of the water duty previously given, and, in the writer's belief, will be considerably less than the 37.2 in. which the author's analysis seems to indicate as the required quantity.

In Harney Valley the problem of determining the consumption is not so simple, but, doubtless, natural facilities were found where it could be determined for certain representative areas.

The writer is delighted with this paper. Mr. Hammatt has attacked an old problem in a novel manner, and has arrived at results which contain an element of surprise. It is to be hoped that, when the time is propitious, he will give the Engineering Profession the benefit of all the data he has gathered.

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PAPERS AND DISCUSSIONS

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DISCUSSION ON FINAL REPORT OF THE SPECIAL COMMITTEE ON STEEL COLUMNS AND STRUTS*

By L. J. Mensch, M. Am., Soc. C. E.

Mr. Mensch.

L. J. Mensch,† M. Am. Soc. C. E. (by letter.)‡—The Committee has presented to the Society the most elaborate series of tests on flat-ended steel columns which were ever made. It is quite a disappointment that these modern tests, made under extremely favorable conditions, often did not show up better than, and sometimes not as well as, the tests on pin-ended iron columns, made by the Watertown Arsenal more than 30 years ago. Under these circumstances, one could not expect the Committee to recommend an increase in the customary working stresses—desirable as this would have been in these times of increasing cost of all construction work.

The Committee has pointed out that, with respect to the transmission of the loads at its ends, the practical column is loaded under conditions differing widely from those of scraped ends in the testing machine.

The writer is really surprised that, during the progress of the tests, no attempt was made to test one column out of three with ends as they came from the bridge works; if this had been done for the slenderness ratios of 120 and 155, the Committee would have found the proper justification for its ruling to allow a working stress of 8 000 lb. per sq. in. for $\frac{l}{r} = 120$, which is a drop of 33% below the

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* Continued from August, 1918, *Proceedings*.

† Chicago, Ill.

‡ Received by the Secretary, September 18th, 1918.

Mr. Mensch. working stress of a column of $\frac{l}{r} = 80$; this, at first glance, would lead one to believe that the ruling is not in accordance with the tests, which showed a drop in strength of only 10% for columns having a slenderness ratio of $\frac{l}{r} = 120$ below the ultimate strengths of columns of $\frac{l}{r} = 85$.

Long columns with imperfect flat ends behave mostly like columns with frictionless pins, but short columns behave like eccentrically-loaded columns. This fact was impressed on the writer by his experience with wooden struts in reinforced concrete form work, and was clearly proved to him during a visit to the Pittsburgh Laboratory of the Bureau of Standards. Mr. P. H. Bates, in charge of the Laboratory, had the kindness to make the following test, in the presence of W. K. Hatt, M. Am. Soc. C. E., and the writer: A sound piece of 2 by 4-in. spruce scantling, 12 ft. long, stored under shelter for many months, was cut off by hand to a length of 6 ft. and placed in the 600 000-lb. machine, between wedges at the bottom and a piece of timber at the top. The maximum load was 4 000 lb., and the deflection about 2 in. The actual dimensions of the strut were only $1\frac{3}{4}$ by $3\frac{5}{8}$ in., hence the ultimate strength was 630 lb. per sq. in. According to the Watertown Arsenal reports for 1884, square-ended struts of green, white pine, of the same slenderness ratio as the spruce strut, failed at 1 700 lb. per sq. in. The two values of 630 and 1 700 show the difference in strength of the practical wooden column and the column with perfectly square ends in a testing machine. Here is the explanation as to why the standard textbooks advise the use of a factor of safety of from 6 to 10 for wooden columns. Such high factors of safety have properly been nicknamed "factors of ignorance."

Iron or steel columns with ideal pin ends and ideal flat ends do not show such a large difference in strength for the slenderness ratios in practical use, but the Committee did not instruct us in this respect. It realized the demand of engineers for a rational column theory, yet, on account of the non-uniformity of commercial grades of steel, and the great influence of the amount of rolling the various sections receive and the resulting difference in the strength of the columns, deemed it advisable not to attempt the task.

Although there was a great difference in strength in light, medium, and heavy-weight sections, the drop in strength in each type, from the comparatively short column having slenderness ratios of $\frac{l}{r} = 50$ to $\frac{l}{r} = 155$, was remarkably uniform, and it is this decrease of strength which engineers want to have explained, it being known for

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many years that the grade of steel and the amount of rolling greatly affect its strength, and it being quite common practice, in reinforced concrete, for example, to allow a higher stress on wires than on bars from which the wires are made.

This deficiency in the report of the Committee the writer will endeavor to supply. A solution of the problem cannot be found by adhering to the common theory of flexure as propounded in the text-books in the stereotyped form:

1 The modulus of elasticity is constant;
2 A plane section before bending remains plane after bending;
3 The direct stresses vary uniformly across the section in all cases (Hooke's law);
4 Calculations are made with references to working stresses and safe loads, rather than with references to ultimate stresses and ultimate loads.

One does not know what "proper working stresses" are unless one makes tests to destruction or undue distortion; therefore, Point 4 leads only to much speculation and many exercises in mathematics, without being conducive to an exact understanding of the strength of materials.

Point 1 has been disproved by all careful observers, and by Figs. 5 and 6 and Plate LVIII of the Committee's report.

Point 2 is disproved by Plates LVI and LVII, and was never proved by anybody for high stresses.

Hooke's law is acknowledged to be only an approximation for steel at low stresses, is certainly far from being correct for high stresses, and is never true for concrete, wood, or cast iron, for any stage of loading.

A correct solution of the beam or column theory can only be found by examining the conditions at the time of failure or just before it.

For this condition the writer makes the following assumption: A column fails when, in any cross-section, the extreme fibers on one side of a cross-section are stressed beyond the yield point and are subjected to a strain which is from 50 to 100% greater than the deformation just below the yield point. Following the lead of the Committee, this maximum strain will be called the Useful Limit Strain (U. L. S.), and the corresponding stress the Useful Limit Point (U. L. P.), which stress is not identical, however, with the point adopted by the Committee.

The Committee did not furnish stress-strain diagrams for the separate angles, plates, or beams, but only for the built-up columns up to failure, which diagrams are somewhat clouded by the influence of the rivet holes and the bending of the columns. Figs. 5 and 6 and

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Plate LVIII show such diagrams, and they can be compared in shape to cubic (or higher) parabolas. Even with the not strictly correct assumption of a plane cross-section remaining plane after deformation, one can readily see that, in any cross-section of a bent column, where the extreme fibers are strained to the U. L. S., the fibers which are quite distant from them, although strained quite considerably less, are subjected to stresses only slightly less than the U. L. P., and very much more than the old straight-line theory would warrant us to assume.

The second assumption, then, is, that a column fails when, in any cross-section, the extreme fibers on one side are stressed to the U. L. P.; and the distribution of the unit stresses over the section follows the law of a cubic parabola. The cubic parabola was adopted because it gave a good and sufficient agreement with tests, and is simpler in application than any higher curve. Fig. 12 shows the outline of such a parabola.

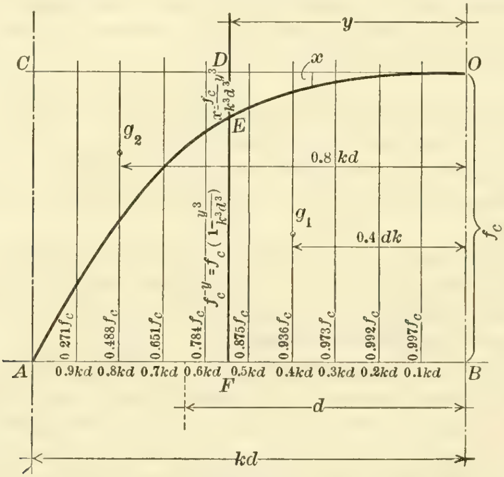

FIG. 12.

Let f_c represent the rise of the parabola and the U. L. P.;

" kd represent the semi-chord and the distance of the neutral axis from the extreme fiber in compression;

then the equation of the parabola is

$$\left.\begin{aligned} y^3 &= \frac{(kd)^3}{f_c}\,x \\ \text{or}\quad x &= \frac{y^3}{k^3\,d^3}\,f_c \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

or the stress, f^y, at any point, y, equals $f_c - x = f_c\left(1 - \frac{y^3}{k^3\,d^3}\right)$ ..(2)

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The area, OAB, represents the sum of all stresses between the neutral axis and the extreme fibers, and equals $\frac{3}{4}\, b\, kd\, f_c$ . . . . (3) when the width of the section is constant and equals b.

$$\text{The area, } OCA = \frac{1}{4}\, b\, kd\, f_c \text{ . . . . (4)}$$

The distance of the centroid of OAB from $OB = 0.4\ kd$. (5)

" " " " " " OCA " " $= 0.8\ kd$. (6)

The tangent at A intersects the x axis at $2\ f_c$ from O.

The writer developed the theory of long columns by first solving the problems of the short eccentrically-loaded column. After he found a substantial agreement between his theory of eccentrically-loaded columns with actual tests to destruction, he found a simple method to determine the sidewise deflection under which long columns fail, and considered a long column at the moment of failure as a short column with a known eccentricity.

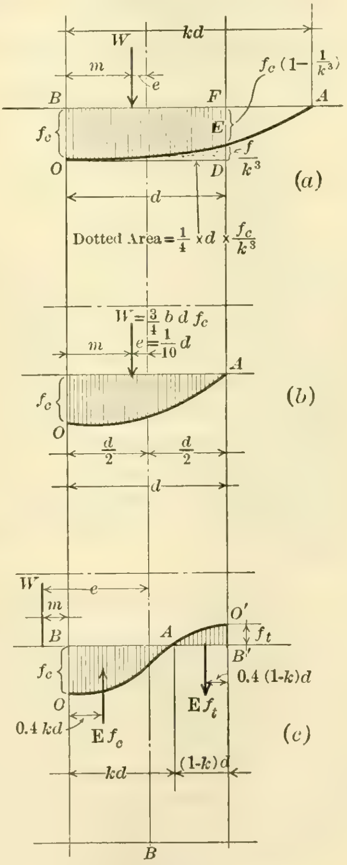
Fig. 13 illustrates short, eccentrically-loaded columns. Where the entire cross-section of the column is in compression, as shown in Fig. 13 (a), the neutral axis is outside of the cross-section, and the value of k is greater than 1.

By increasing the eccentricity we may reach a case where the neutral axis coincides with one edge of the section, such as shown in Fig. 13 (b). Here k equals 1.

For larger eccentricities, the neutral axis will fall inside of the section, as shown in Fig. 13 (c), and k becomes smaller than 1.

For a rectangular cross-section, it is a very simple matter to find a relation between the ultimate load, its eccentricity, the dimensions of the cross-section, and the U. L. P.

RECTANGULAR SECTION



DEFORMATION
ACCORDING
TO A CUBIC PARABOLA.

FIG. 13.

Mr. Mensch.

For Fig. 13 (*a*) we easily find that the sum of all stresses,

$$W = b \times \text{area } OBDF - b \times \text{area } OED,$$

or $$W = b \times d\ f_c - b \times \frac{1}{4}\ d \times f_c \times \frac{1}{k^3} = b\ d\ f_c \left(1 - \frac{1}{4\ k^3}\right) \quad \ldots (7)$$

The moment of the load, *W*, about the extreme fibers in compression,

$$M = b \times \text{area } OBDF \times \frac{1}{2}\ d - b \times \text{area } OED \times 0.8\ d$$

$$= b\ d^2\ f_c \left(\frac{1}{2} - \frac{0.2}{k^3}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

The distance of *W* from the extreme fibers in compression, $m = \frac{M}{W}$, and the eccentricity under which the column fails,

$$e = \frac{1}{2}\ d - m = \frac{0.075\ d}{k^3 - \frac{1}{4}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

For $k = 1$, Equations (7) to (9) simplify to

$$W = \frac{3}{4}\ b\ d\ f_c,\ M = 0.3\ b\ d^2\ f_c, \text{ and } e = 0.1\ d \quad \ldots\ldots (10)$$

For *kd* smaller than *d*, or *k* smaller than 1, we have to distinguish two cases. In one case, as in brick or other masonry columns and in foundations, no tensile stresses can be counted on, and the distribution of stresses will be according to Fig. 14. *W* equals, again, the area, *OAB*, multiplied by *b*, and the location of *W* is given by the centroid of the parabola.

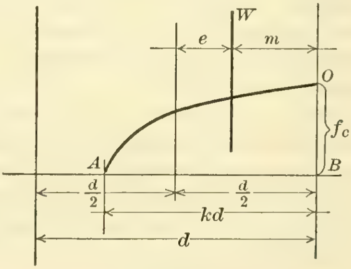


FIG. 14.

$$W = \frac{3}{4}\ b\ kd\ f_c, \text{ and } e = \frac{1}{2}\ d - m = \frac{1}{2}\ d - 0.4\ kd \quad \ldots\ldots (11)$$

It is quite evident that, in this case, *W* can at no time fall outside of the section. Materials which possess tensile strength will allow *W* to fall outside, in which case the effect of the eccentric loading will approach girder action. For this case we can only make our theory agree with tests by making a third assumption, namely, that the extreme fibers in tension and compression attain the U. L. P. simultaneously at the time of failure.

From Fig. 13 (*c*) we have $W + \Sigma f_t = \Sigma f_c$,

or $$W = b \times \text{area } OAB - b \times \text{area } O'AB',$$

$$W = b\,\frac{3}{4}\ kd\ f_c - b\,\frac{3}{4}\ (1 - k)\ d\ f_t = \frac{3}{4}\ b\ d\ f_c \left\{ k - (1 - k)\,\frac{f_t}{f_c} \right\} \quad ..(12)$$

Mr. Mensch.

$$M = b \times \text{area } OAB \times 0.4\,kd - b \times \text{area } O'\,AB' \times \left\{ d - (1 - k)\,0.4\,d \right\}$$

$$M = \frac{3}{40}\,b\,d^2\,f_c \left\{ 4\,k^2 - \frac{f_t}{f_c}\,(6 - 2\,k - 4\,k^2) \right\} \ldots\ldots (13)$$

$m = \frac{M}{W}$, and $e = \frac{1}{2}\,d - m$.

Where M becomes negative, m is negative, and it means that the point of application of W falls outside of the section. The ratio of $\frac{f_t}{f_c}$ is about 1 for structural steel, $\frac{1}{10}$ for concrete, $\frac{1}{5}$ for cast iron, and 1.25 for green timber.

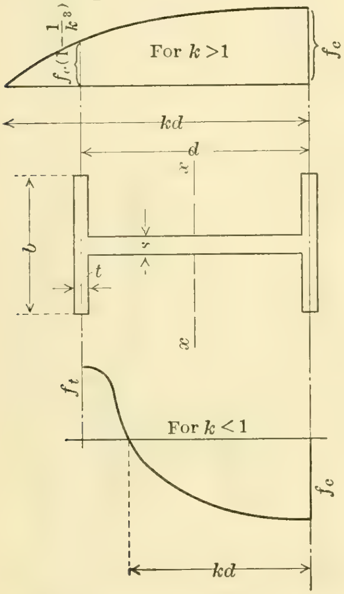


FIG. 15.

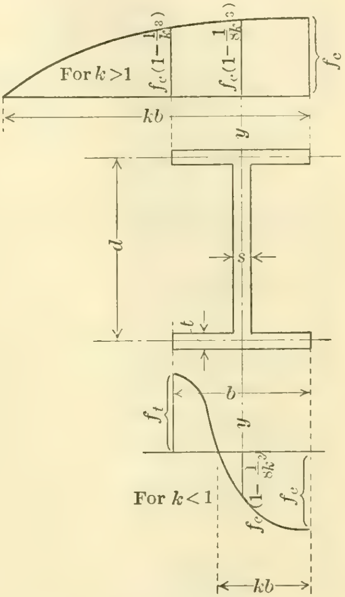


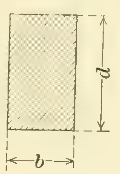
FIG. 16.

Equations (7) to (13) enable us to find W and e for rectangular sections when k is known. By giving k various values from 3 to 0.6, for example, we may obtain a series of values of W and e which will include nearly all cases found in practice. This has been done, and the results may be found in Table 25, Columns 1 and 2. For example, for $k = 1.5$, it is found that $W = 0.926\,b\,d\,f_c$, and $e = 0.024\,d$. The short concentrically-loaded column can carry the load, $b\,d\,f_c$; therefore, the eccentrically-loaded column carries in this case only 92.6% of that load.

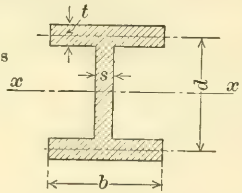
The tests by the Committee were made on sections which in most cases can be considered as being composed of rectangles. For the purpose of a simplified theory, we will idealize the sections, like those shown by Figs. 15 and 16. Let A, the entire cross-sectional area, $= 2\,b\,t + d\,s$.

Mr. Mensch.

TABLE 25.—ULTIMATE LOADS AND ECCENTRICITIES AT FAILURE OF STRUCTURAL STEEL COLUMNS.



Column is assumed
to bend at right angles
to x-axis



Area of Flange $= b\,t$
" " Web $= d\,s$
Full Area $= 2\,b\,t + d\,s = A$
$\frac{bt}{A} = n$, $\frac{ds}{A} = n_1$

				$n = 0.25$, $n_1 = 0.50$			$n = 0.290$, $n_1 = 0.42$			$n = 0.333$, $n_1 = 0.333$			$n = 0.375$, $n_1 = 0.25$			$n = 0.400$, $n_1 = 0.20$		
Radius of gyration				$0.407\,d$			$0.425\,d$			$0.443\,d$			$0.456\,d$			$0.465\,d$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
K	$\frac{W}{b\,d\,f_c}$	$\frac{e}{d}$	$\frac{e\,k}{d}$	$\frac{W}{A\,f_c}$	$\frac{e}{d}$	$\frac{e\,k}{d}$	$\frac{W}{A\,f_c}$	$\frac{e}{d}$	$\frac{e\,k}{d}$	$\frac{W}{A\,f_c}$	$\frac{e}{d}$	$\frac{e\,k}{d}$	$\frac{W}{A\,f_c}$	$\frac{e}{d}$	$\frac{e\,k}{d}$	$\frac{W}{A\,f_c}$	$\frac{e}{d}$	$\frac{e\,k}{d}$
3.0	0.991	0.003	0.009	0.986	0.006	0.018	0.985	0.006	0.018	0.985	0.007	0.021	0.984	0.008	0.024	0.984	0.009	0.025
2.0	0.969	0.010	0.020	0.953	0.022	0.043	0.951	0.023	0.046	0.948	0.024	0.047	0.945	0.028	0.056	0.944	0.029	0.057
1.50	0.926	0.024	0.036	0.889	0.055	0.082	0.883	0.058	0.087	0.877	0.065	0.098	0.871	0.070	0.105	0.867	0.074	0.111
1.30	0.886	0.038	0.049	0.829	0.090	0.116	0.820	0.097	0.126	0.810	0.108	0.140	0.801	0.117	0.152	0.795	0.122	0.159
1.10	0.812	0.069	0.076	0.718	0.170	0.187	0.703	0.187	0.206	0.687	0.209	0.230	0.671	0.230	0.253	0.662	0.244	0.269
1.00	0.750	0.100	0.100	0.625	0.260	0.260	0.605	0.228	0.288	0.583	0.329	0.329	0.563	0.370	0.370	0.550	0.391	0.391
0.85	0.638	0.160	0.136	0.263	1.24	1.05	0.221	1.60	1.36	0.175	2.20	1.87	0.131	3.15	2.68	0.105	4.10	3.49
0.80	0.600	0.180	0.144	0.225	1.50	1.20	0.189	1.91	1.53	0.150	2.60	2.08	0.113	3.71	2.98	0.090	4.76	3.81
0.70	0.525	0.220	0.154	0.150	2.33	1.64	0.126	2.98	2.09	0.100	4.00	2.80	0.075	5.65	3.96	0.060	7.35	5.15
0.60	0.450	0.260	0.156	0.075	4.79	2.87	0.063	6.05	3.10	0.050	8.10	4.86	0.038	11.5	6.90	0.030	14.80	8.88

W = Ultimate load ; A = Area of cross-section ; f = Useful Limit Point ; e = Eccentricity.

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Let $\frac{b\,t}{A} = n$, $\frac{d\,s}{A} = n_1$, and $f_t = f_c$.

For bending under right angle to the X-axis and for $k > 1$, we easily find, considering Equations (7) and (8):

$W = b\ t\ f_c + d\ s\ f_c \left(1 - \frac{1}{4\,k^3}\right) + b\ t\ f_c \left(1 - \frac{1}{k^3}\right)$, which easily reduces to

$$W = A\ f_c \left(1 - \frac{n + \frac{n_1}{4}}{k^3}\right) \ldots\ldots\ldots\ldots\ldots\ldots (14)$$

$$M = s\,d^2\,f_c\ \left(\frac{1}{2} - \frac{0.2}{k^3}\right) + b\ t\ f_c\ \left(1 - \frac{1}{k^3}\right) d,$$

$$M = A\ d\ f_c \left(\frac{1}{2} - \frac{n + 0.2\ n_1}{k^3}\right) \ldots\ldots\ldots\ldots\ldots (15)$$

For $k < 1$, $W = b\ t\ f_c + s\ k\,d\ \frac{3}{4}\ f_c - b\ t\ f_t - s\,(1 - k)\ d\ \frac{3}{4}\ f_t$,

for $f_t = f_c$, this reduces to $W = \frac{3}{4}\ s\ d\ f_c\ (2\ k - 1) \ldots .\ (16)$

$$M = \frac{3}{4}\ s\ kd\ f_c \times \frac{4}{10}\,d - b\,t\,f_t\,d - \frac{3}{4}\ s\,d\,f_t\,(1 - k) \times \left\{d - 0.4\,(1 - k)\,d\right\}$$

for $f_t = f_c$, $M = 0.6\ s\ d^2\,f_c\ \left(k^2 + \frac{1}{4}\ k - \frac{3}{4} - 10\,\frac{n}{6\ n_1}\right) \ldots .\ (17)$

For bending under right angle to the Y-axis, as shown in Fig. 16, and for $k > 1$:

$$W = 2\ b\ t\ f_c\ \left(1 - \frac{1}{4\ k^3}\right) + s\ d\ f_c\ \left(1 - \frac{1}{8\ k^3}\right)$$

$$= A\ f_c\ \left(1 - \frac{4\ n + n_1}{8\ k^3}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (18)$$

$$M = 2\,t\,b^2\,f_c\ \left(\frac{1}{2} - \frac{0.2}{k^3}\right) + s\ d\ f_c\ \left(1 - \frac{1}{8\ k^3}\right) \times \frac{1}{2}\ b.$$

$$M = A\ b\ f_c\ \left(\frac{1}{2} - \frac{6.4\ n + n_1}{16\ k^3}\right) \ldots\ldots\ldots\ldots\ldots (19)$$

For $k < 1$, and considering Equations (12), (13), and (2):

$$W = 2 \times \frac{3}{4}\ b\ t\ f_c\ (2\ k - 1) + d\ s\ f_c\ \left(1 - \frac{1}{8\ k^3}\right)$$

$$= A\ f_c\ \left(3\ k \times n - 1 \times 5\ n + n_1 - \frac{n_1}{8\ k^3}\right) \ldots\ldots\ldots (20)$$

$$M = \frac{3}{40} \times t\ b^2\ f_c\ (8\ k^2 + 2\ k - 6) \times 2 + d\ s\ f_c \left(1 - \frac{1}{8\ k^3}\right)\ \frac{1}{2}\ b.$$

$$M = A\ b\ f_c \left(1.2\ k^2 \times n + 0.30\ k\ n - 0.9\ n + \frac{1}{2}\ n_1 - \frac{n_1}{16\ k^3}\right) \ldots (21)$$

Mr. Mensch. Equations (16) and (17), also (20) and (21), cannot be used for $k = 1$, because the assumption was made that the full U. L. P is acting on the tension side. It is very probable that the neutral axis must be at a fixed proportion of the depth distant from the extreme fibers in tension before these fibers are stressed to the U. L. P. The writer believes that this is the case for values of k smaller than 0.9 or 0.85. When W and M are known, we easily find $m = \frac{M}{W}$ and $e = \frac{1}{2} d - m$.

These values have been computed for various values of k and n, and may be found in Table 25, Columns 4 to 17. The values of n were selected in conformity with the specimen tested by the Committee.

For example, Type 1 corresponds to $n = 0.272$
" 1A " " $= 0.282$
" 2 and 2A " " $= 0.33$
" 3 " 3A " " $= 0.40$
" 5 " " $= 0.38$
" 5A " " $= 0.40$

To the right of the columns containing the figures for $\frac{e}{d}$ in Table 25 is found another series of figures which are obtained by multiplying k by $\frac{e}{d}$, giving the values of $\frac{e\,k}{d}$, which are of great importance in the theory of long columns, as will be shown presently.

Theory of Long Columns.—It is known that long columns which are concentrically loaded at knife-edge points fail by buckling. This buckling is the result of some interior eccentricity which, as a rule, is not sufficiently large to produce a noticeable deflection at low loads; but, when the loads become high, especially after the yield point is exceeded in the extreme fibers of a section, the moments are sufficiently large to produce an appreciable deflection. This causes the line of application of the load to fall outside of the center line of the column, as shown in Fig. 17, much more than is due to the original eccentricity, and, under this enlarged eccentricity, the column finally fails. The problem of the strength of a long column is thus reduced to finding the eccentricity of the deflected column. This, of course, is very difficult, because we do not know how large the interior eccentricity is nor how it is distributed, and because we are

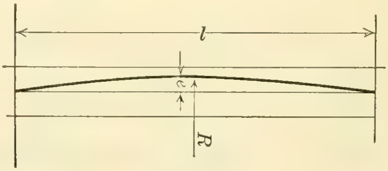

FIG. 17.

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not yet in possession of the laws governing the flow of the materials after the yield point is exceeded, or of the laws of the deformation of a cross-sectional plane. In the practical column the deflection is so small, in comparison with the length of the column, that we cannot go far out of the way in assuming that the curve of the elastic line is a parabola or a part of a circle. If the radius of the circle is known we can find at once the rise of the curve, and, therefore, the eccentricity of the deflected column.

Fig. 18 shows a coupon of a column under ultimate load. The original prism, of the length Δl, becomes a bent frustum, and the greatest compressive strain in the extreme fiber equals the U. L. S. (here called ε) multiplied by Δl. We can now find the radius of curvature of the bent column, at the point where the U. L. P. is first reached, by the same reasoning as used in the theory of beams, and can establish the proportion,

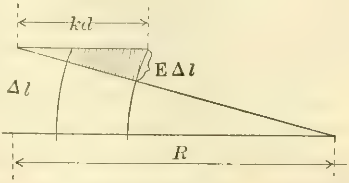

FIG. 18.

$$\frac{R}{\Delta l} = \frac{k d}{\varepsilon \Delta l}, \text{ or } R = \frac{k d}{\varepsilon} \quad \ldots\ldots\ldots\ldots\ldots\ldots (22)$$

but it is known that, in a circle or a parabola with the radius of curvature, R, at the crown, the rise, $e = \frac{l^2}{8 R}$, or from Equation (22), $e = \frac{\varepsilon}{8} \frac{l^2}{k d}$, which can also be written in the form,

$$\frac{e k}{d} = \frac{\varepsilon}{8} \frac{l^2}{d^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (23)$$

The right side of Equation (23) depends only on the known dimensions of the column and on the supposedly known U. L. S., hence $\frac{e k}{d}$ can be computed for each column to be investigated. Table 25, however, contains values of $\frac{e k}{d}$ for all practical cases; therefore, we can find the strength of a long column in terms of the strength of the correspondingly short column which fails by being stressed to the U. L. P. over the entire section, by computing the value of $\frac{\varepsilon}{8} \frac{l^2}{d^2}$ and by finding in Table 25 the corresponding value for W. The writer has found a good agreement with tests by assuming:

$\varepsilon = 0.0015$ for mild steel, plain concrete, hard brick laid in cement mortar, and for terra cotta block columns;
$\varepsilon = 0.01$ for hooped concrete and for cast iron;
$\varepsilon = 0.004$ for green timber;
$\varepsilon = 0.0026$ for common brick laid in cement mortar.

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The conditions of perfectly hinged ends are very rare in a testing machine, as the Watertown Arsenal tests plainly show; such conditions occur, however, in most columns used in building construction, as will be shown later.

The writer will now investigate the behavior of columns with perfect flat ends, such as in the tests which the Committee has presented. As stated before, on account of some slight interior eccentricity, the column will deflect at a certain stage of loading, and, if the ends are not fixed, will try to change their slope, as shown in Fig. 19. The platens of the machine being fixed, either by the construction of the machine or by friction, this tendency is overcome by an eccentric application of the load, such as shown in Fig. 20. The form of the elastic line of the bent column with flat ends is similar to that of a uniformly-loaded beam with end restraint. From the ordinary theory of beams, it is known that the moments at the ends are twice as large as in the center. This, however, is only true as long as the yield point is not reached. The fibers of a beam of uniform section will first exceed the yield point at the ends, causing there a comparatively large deformation, which has the same effect as if the restraint is slightly loosened, thereby allowing the moments in the center to become larger. The few tests which were made on continuous beams, and especially on continuous plates, confirm this reasoning. Probably there is no error, then, in assuming that the new line of application of the load, $o'\, o'_1$, divides the deflection, $l\ m$, in two. It is known, besides, from Euler's theory for very long columns, that this is the case, and that the intersection of the new line of application of the load with the elastic line divides also the column length in two.

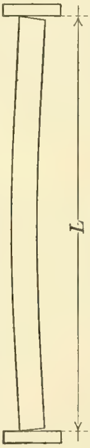

FIG. 19.

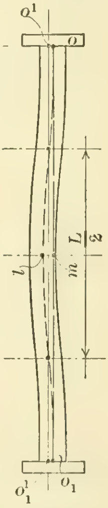

FIG. 20.

Hence, the problem of the strength of a column with perfect flat ends can be reduced to the problem of the strength of a column with perfect hinged ends by assuming the former column to be only of half the length of the latter.

For flat-ended columns, Equation (23) becomes

$$\frac{e\ k}{d} = \frac{\varepsilon}{8}\,\frac{\left(\frac{l}{2}\right)^2}{d^2} = \frac{\varepsilon}{32}\,\frac{l^2}{d^2} \quad \text{.................. (24)}$$

It must be borne in mind that this equation is based on conditions which are not always obtained in the tests. The principal condition is that the moments at the ends shall equal the moment in the center; in fact, the tendency is always there to make the moment at the ends

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larger. As long as k is greater than 1, every point of the end will be still in contact with the platens of the machine, and the restraint of the ends is bound to be in full action when perfect ends are used; but, where the column is so long that k becomes smaller than 1, only part of the ends will be in contact with the platens, the slope of the ends will change, and we will again approach the condition illustrated in Fig. 19. For the understanding of column action, it must also be remembered that a column with perfectly hinged ends at the time of failure must have a slope at its ends, given by the tangent to the elastic line. It does not make any difference whether we consider the elastic line as a circle or a sine curve, the tangent is given by $\alpha = 3.2 \frac{e}{l}$, or, substituting the value of e from Equation (23), we obtain

$$\alpha = \frac{3.2}{l} \times \frac{\varepsilon}{8} \frac{l^2}{k\,d} = 0.4 \frac{\varepsilon\, l^2}{k\,d} \ldots\ldots\ldots\ldots\ldots (25)$$

Inversely, we can say that a column which has the slope, α, as given by Equation (25), at its ends, must act like a column with ideal hinged ends, regardless of whether it appears to be flat-ended or continuous.

Where the angle at the ends is much smaller than given by Equation (25) the column action lies between that of flat and hinged ends. Columns with perfect flat ends are probably extremely rare in actual practice. The rigid heads of the testing machine are infinitely stiffer than the ordinary beam connections in building work. It is known from Euler's theory that ordinary continuation of columns does not make them act as flat-ended. In order to make the column act as a flat-ended one, there must be, at each story, a rigid connection which can transmit the full bending moment, $W\,e$, of the column to the connecting girders without undue deformation—an extremely rare case in practice.

It is a very difficult matter to prove that the quantities, $\frac{e}{d}$, of Table 25, are in accordance with the tests. By inspecting on Plate LVII the deflections for the middle of the column, we find that, for a load of 280 140 lb. the deflection is 0.3717 in., and for the ultimate load of 289 800 lb. the deflection is 1.995 in., which means that for an increase of 3% of the load, the deflection increases 150%; therefore, the deflections given in Tables 1 to 5 of the report must be considerably smaller than the deflections found by the writer's theory.

To prove that this theory is sustained by the tests of the Committee, Table 26 has been prepared. Only the tests of columns which have sections in conformity with Figs. 15 and 16 were used. The values of $\frac{e\,k}{d}$ were found by Equation (24), and the U. L. P. of each type was

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found from the average unit ultimate strength for the slenderness ratio of $\frac{l}{r} = 50$ by dividing the ultimate unit stress by the percentage given in the next column.

TABLE 26.—Comparison of Actual and Theoretical Ultimate Loads.

Type.	Value of n.	Length.		Depth of Section, in Inches.		Slenderness Ratio.		$\frac{e\,k}{d}$, from Equation (24)	Average unit ultimate loads. Bureau of Standards tests.	U. L. P. derived from $\frac{l}{r} = 50$.	Average Unit Ultimate Load from Theory.	
		Feet.	Inches.	d	b	$\frac{l}{r}$	$\frac{l}{d}$				Percentage of U. L. P.	Pounds per square inch.
1....	0.272	9	4	$5\frac{11}{16}$	......	50	19.7	0.0182	32 700	33 200	0.986	32 700
		15	$10\frac{7}{16}$	$5\frac{11}{16}$	......	85	33.4	0.052	31 200	33 200	0.946	31 400
		22	$4\frac{13}{16}$	$5\frac{11}{16}$	......	120	47.2	0.108	28 300	33 200	0.848	28 100
		28	$11\frac{3}{16}$	$5\frac{11}{16}$	......	155	61.0	0.174	26 200	33 200	0.750	24 900
1 *A*..	0.282	9	10	$5\frac{3}{8}$	......	50	22.0	0.023	29 200	29 750	0.982	29 200
		16	$8\frac{5}{8}$	$5\frac{3}{8}$	......	85	37.4	0.066	28 100	29 750	0.920	27 400
		23	$7\frac{3}{16}$	$5\frac{3}{8}$	......	120	52.7	0.127	25 400	29 750	0.820	24 400
		30	$5\frac{13}{16}$	$5\frac{3}{8}$	......	155	68.0	0.216	22 700	29 750	0.700	20 900
3....	0.41	9	9	$5\frac{1}{8}$	......	50	19.0	0.017	34 100	34 600	0.986	34 600
		16	$6\frac{7}{8}$	$5\frac{1}{8}$	......	85	32.4	0.049	32 400	34 600	0.950	32 900
		23	$4\frac{13}{16}$	$5\frac{1}{8}$	......	120	45.7	0.098	30 300	34 600	0.884	30 500
3 *A*..	0.40	9	$11\frac{1}{2}$	$5\frac{3}{8}$	......	50	18.6	0.016	29 500	29 900	0.986	29 500
		15	$11\frac{1}{8}$	$5\frac{3}{8}$	......	85	31.5	0.047	28 000	29 900	0.958	28 600
		23	$10\frac{13}{16}$	$5\frac{3}{8}$	......	120	44.5	0.093	26 900	29 900	0.894	26 700
5....	0.38	8	3	......	8	50	12.3	0.007	38 000	38 800	0.987	38 800
		14	$0\frac{5}{16}$	......	8	85	21.0	0.021	34 300	38 800	0.951	36 900
		19	$9\frac{5}{8}$	......	8	120	29.7	0.041	32 000	38 800	0.875	33 800
5 *A*..	0.40	8	$8\frac{1}{2}$	......	8	50	13.0	0.008	35 400	35 900	0.986	35 400
		14	$9\frac{5}{8}$	......	8	85	22.2	0.023	32 300	35 900	0.951	34 100
		20	$10\frac{13}{16}$	......	8	120	31.3	0.046	30 000	35 900	0.872	31 300

The percentage of the strength of the short concentrically-loaded column, which a long column carries, was found from the $\frac{e\,k}{d}$ given in Table 26 by interpolation in the proper columns of Table 25. It is found that this theory agrees with the tests in most cases within 5 per cent.

For very short columns, as, for example, the slenderness ratios of $\frac{l}{r} = 20$, this theory does not seem to apply, on account of the so-called block action, for which, at present, the writer has no explanation to offer.

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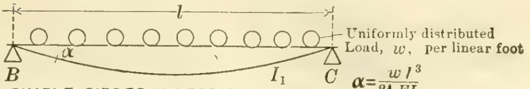
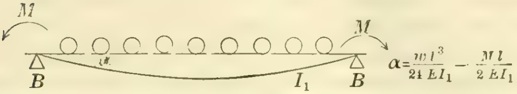


l
Uniformly distributed Load, w, per linear foot
α
B
I_1
C
$\alpha = \frac{w l^3}{24 EI_1}$

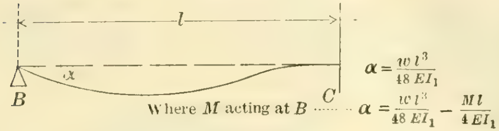
SIMPLE GIRDER UNIFORMLY LOADED.

FIG. 21.



SIMPLE GIRDER, WITH MOMENTS, M, ACTING AT ITS ENDS.

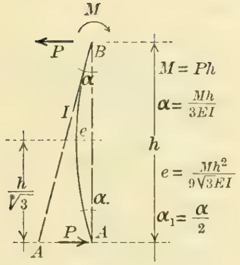
FIG. 22.



l
α
B
C
$\alpha = \frac{w l^3}{48 EI_1}$
Where M acting at B ······ $\alpha = \frac{w l^3}{48 EI_1} - \frac{Ml}{4 EI_1}$

GIRDER FIXED AT ONE END;
SIMPLY SUPPORTED AT THE OTHER END.

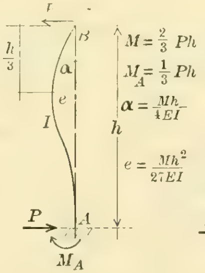
FIG. 23.



M
P
B
α
I
e
$\frac{h}{\sqrt{3}}$
$\alpha.$
P
A
A
h
$M = Ph$
$\alpha = \frac{Mh}{3EI}$
$e = \frac{Mh^2}{9\sqrt{3}EI}$
$\alpha_1 = \frac{\alpha}{2}$

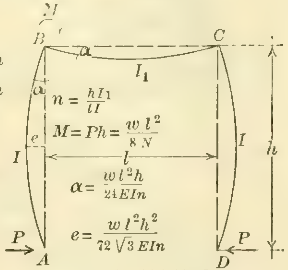
COLUMN AFFECTED
BY A MOMENT,
M, ON TOP AND FORCES, P,
AT THE ENDS
BOTTOM OF COLUMN
NOT FIXED.

FIG. 24.



AS IN FIG. 24
BUT BOTTOM OF
COLUMN IS FIXED.

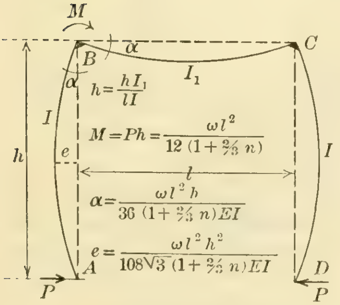
FIG. 25.



M
B
C
α
I_1
α
$n = \frac{hI_1}{lI}$
e
$M = Ph = \frac{w l^2}{8 N}$
I
l
I
h
$\alpha = \frac{w l^2 h}{24EIn}$
$e = \frac{w l^2 h^2}{72\sqrt{3} EIn}$
P
A
D
P

TWO COLUMNS
WITH GIRDER RESTING LOOSE
ON TOP OF COLUMNS
BOTTOM OF COLUMNS
NOT FIXED.

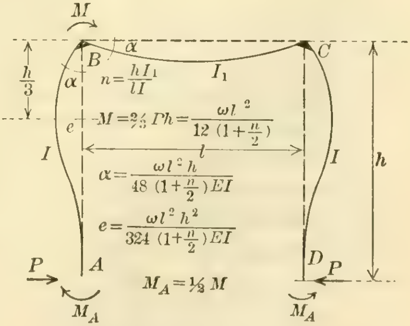
FIG. 26.



M
B
α
C
I_1
α
$h = \frac{hI_1}{lI}$
I
$M = Ph = \frac{\omega l^2}{12\,(1 + \frac{2}{3} n)}$
h
e
I
l
$\alpha = \frac{\omega l^2 h}{36\,(1 + \frac{2}{3} n) EI}$
$e = \frac{\omega l^2 h^2}{108\sqrt{3}\,(1 + \frac{2}{3} n) EI}$
A
D
P
P

TWO COLUMNS,
WELL-CONNECTED WITH GIRDER AT TOP.
BOTTOM OF COLUMNS NOT FIXED.

FIG. 27.



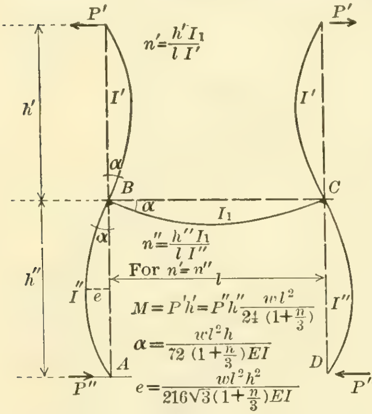
M
B
α
C
$\frac{h}{3}$
α
$n = \frac{hI_1}{lI}$
I_1
e
$M = \frac{2}{3} Ph = \frac{\omega l^2}{12\,(1 + \frac{n}{2})}$
I
l
I
h
$\alpha = \frac{\omega l^2 h}{48\,(1 + \frac{n}{2}) EI}$
$e = \frac{\omega l^2 h^2}{324\,(1 + \frac{n}{2}) EI}$
P
A
D
P
$M_A = \frac{1}{2} M$
M_A
M_A

AS IN FIG. 27,
BUT BOTTOM OF COLUMN IS FIXED.

FIG. 28.

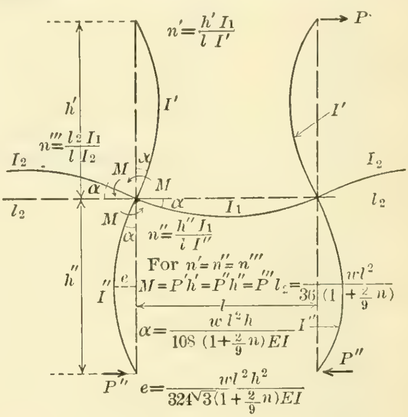
Mr. Mensch.

The Committee discourages the use of longer columns than $\frac{l}{r} = 120$, although its tests on $\frac{l}{r} = 155$ still give very high values. That long columns in actual use are so much weaker than short columns is due to the fact that the girders connecting them exert a moment on such columns, cause them to deflect, and change their slopes at the ends, and we have, instead of the flat-ended column of the testing machine, a hinged column with eccentric loading. Figs. 21 to 34 explain this point. The indeterminate values of the moments and


P'
P'
$n' = \frac{h' I_1}{l I'}$
h'
I'
I'
α
B
C
α
I_1
α
$n'' = \frac{h'' I_1}{l I''}$
For $n' = n''$
l
h''
I''
e
$M = P'h' = P''h'' \frac{wl^2}{24\left(1+\frac{n}{3}\right)}$
I''
$\alpha = \frac{wl^2 h}{72\left(1+\frac{n}{3}\right)EI}$
A
D
P''
$e = \frac{wl^2 h^2}{216\sqrt{3}\left(1+\frac{n}{3}\right)EI}$
P''

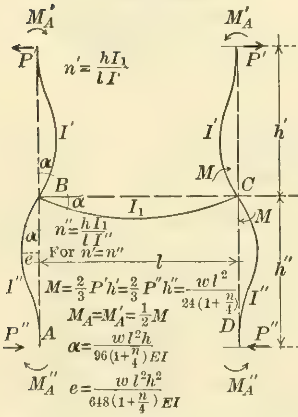
TWO TWO-STORY COLUMNS
WITH GIRDER WELL CONNECTED.
ENDS OF COLUMNS NOT FIXED.

FIG. 29.


$n' = \frac{h' I_1}{l I'}$
P
h'
I'
I'
$n''' = \frac{l_2 I_1}{l I_2}$
I_2
I_2
M
α
M
l_2
α
I_1
l_2
M
α
$n'' = \frac{h'' I_1}{l I''}$
For $n' = n'' = n'''$
h''
I''
e
$M = P'h' = P''h'' = P'''l_2 = \frac{wl^2}{36\left(1+\frac{2}{9}n\right)}$
l
$\alpha = \frac{wl^2 h}{108\left(1+\frac{2}{9}n\right)EI}$
I''
P''
P''
$e = \frac{wl^2 h^2}{324\sqrt{3}\left(1+\frac{2}{9}n\right)EI}$

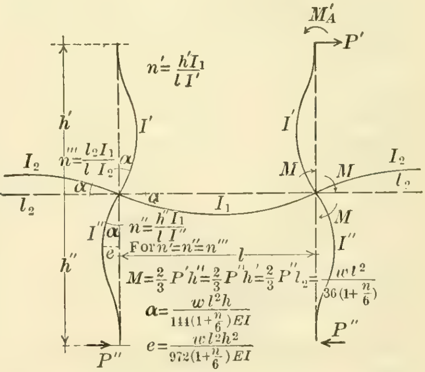
AS IN FIG. 29
BUT THE GIRDER
IS CONTINUOUS.

FIG. 30.


M'_A
M'_A
P
$n' = \frac{h I_1}{l I'}$
P'
I'
I'
h'
α
M
B
C
α
I_1
M
α
$n'' = \frac{h I_1}{l I''}$
e
For $n' = n''$
l
h''
I''
$M = \frac{2}{3}P'h' = \frac{2}{3}P''h'' = \frac{wl^2}{24\left(1+\frac{n}{4}\right)}$
I''
$M_A = M'_A = \frac{1}{2}M$
P''
A
D
P''
$\alpha = \frac{wl^2 h}{96\left(1+\frac{n}{4}\right)EI}$
M''_A
$e = \frac{wl^2 h^2}{648\left(1+\frac{n}{4}\right)EI}$
M''_A

AS IN FIG. 29 BUT THE COLUMNS
ARE FIXED AT THE ENDS.

FIG. 31.


M'_A
P'
$n' = \frac{h' I_1}{l I'}$
h'
I'
I'
I_2
$n''' = \frac{l_2 I_1}{l I_2}$
α
M
M
I_2
l_2
α
α
I_1
l_2
M
I''
α
$n'' = \frac{h'' I_1}{l I''}$
I''
e
For $n' = n'' = n'''$
l
h''
$M = \frac{2}{3}P'h'' = \frac{2}{3}P''h' = \frac{2}{3}P''l_2 = \frac{wl^2}{36\left(1+\frac{n}{6}\right)}$
$\alpha = \frac{wl^2 h}{144\left(1+\frac{n}{6}\right)EI}$
P''
$e = \frac{wl^2 h^2}{972\left(1+\frac{n}{6}\right)EI}$
P''

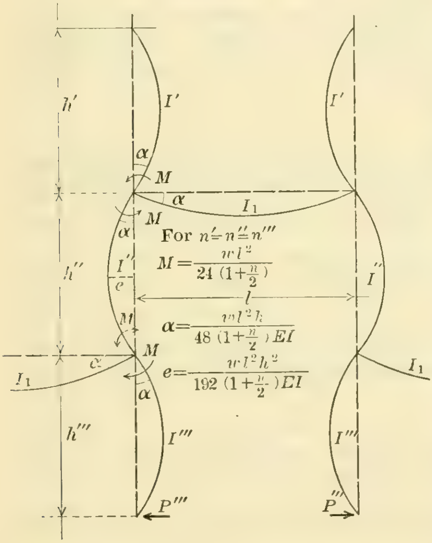
AS IN FIG. 29
BUT THE GIRDERS ARE CONTINUOUS,
AND COLUMNS FIXED AT THE ENDS.

FIG. 32.

Mr. Mensch.

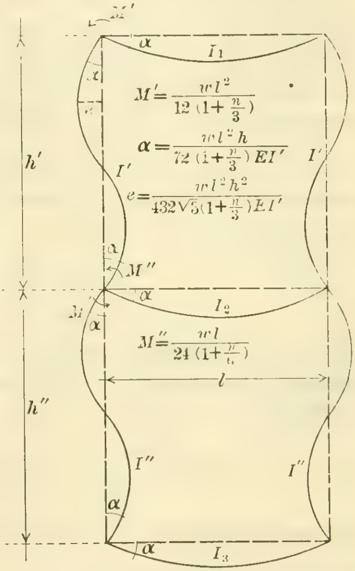
thrusts were found by the slope and deflection method, and the assumption was made that the slope of a girder at the junction with a column is the same as the slope of the column at the junction. The main point to be learned from these figures is the fact that a moment is exerted by the girders on one or both ends of a column, and that the column deflects either like a hinged column of the length, h, or in some cases of the length, $\frac{3}{4}h$, and only in very rare cases of the length, $\frac{1}{2}h$.

In most cases it will be sufficient to compute a column like a short column, eccentrically loaded by the moment, M, shown in Figs. 21 to 34; but, in the case of very slender columns, it will be necessary to find the moment caused by the girder at the point of the greatest deflection of the columns and to combine the eccentricity caused by the moment with the eccentricity caused by the deflection of the column.



TWO THREE-STORY COLUMNS, WITH GIRDERS ON OPPOSITE SIDES OF THE COLUMNS.

Fig. 33.



TWO MANY-STORY COLUMNS, WITH GIRDERS LOADED AT EACH FLOOR.

Fig. 34.

As an example, assume a frame like Fig. 27, consisting of two 8-in. **H** columns, weighing 32 lb. per ft., 30 ft. high, and well connected with a B-30 Bethlehem **I**-beam, carrying a load of 100 000 lb. on a span of 40 ft.

The moment of inertia of B-30 = 5 240 in.^{4}
" " " " 8-in. **H** = 106 "

Mr. Mensch.

therefore, in Fig. 27, $n = \frac{30 \times 5\,240}{40 \times 106} = 37.1$, and the moment at the junction of column and girder, as shown in Fig. 27,

$$M = \frac{100\,000 \times 40}{12\left(1 + \frac{2}{3}\,37.1\right)} = 13\,000 \text{ ft-lb.}$$

If the column is considered as a short compression member affected by this moment, it is found that $e = \frac{13\,000}{50\,000} = 0.26$ ft., or $\frac{e}{d} = \frac{0.26}{0.666} = 0.39$.

From Columns 14 and 13 of Table 25, it is found that $\frac{e}{d} = 0.391$ corresponds to a percentage of strength of 55. Assuming the U. L. P. as 35 000 lb., the column would fail at an average unit load of $35\,000 \times 0.55 = 19\,250$ lb., or a total load of $19\,250 \times 9.17 = 176\,500$ lb. The actual load being only 50 000 lb., or 5 460 lb. per sq. in., the factor of safety is $\frac{176\,500}{50\,000} = 3.53$.

If it is desired to consider the deflection of the column, one may proceed in the following manner: The greatest deflection will be at the center, and, at the time of failure, is given, according to Equation (23), by

$$\frac{e\,k}{d} = \frac{0.0015 \times 30^2}{8 \times 0.67^2} = 0.75 \ldots\ldots\ldots\ldots (26)$$

The moment exerted by the girder in half of the column height is only one-half the moment at the junction, or 6 300 ft-lb., and the corresponding eccentricity,

$$e_1 = \frac{6\,300}{50\,000} = 0.126 \text{ ft., or } \frac{e_1}{d} = \frac{0.126}{0.666} = 0.189 \ldots (27)$$

We have now to add $\frac{e}{d}$ and $\frac{e_1}{d}$, in order to find the total eccentricity under which the column fails, but this cannot be done at once, because we do not know, *a priori*, the value of k in Equation (26). The addition must be accomplished by trial. Assuming $k = 1$, we find from Equation (26) $\frac{e}{d} = 0.75$, adding $\frac{e_1}{d}$ from Equation (27), the total $\frac{e}{d} = 0.75 + 0.189 = 0.939$. From Columns 14 and 13 of Table 25, it may be seen that the ratio of $\frac{e}{d} = 0.939$ is between the values of $k = 1$ and $k = 0.85$, and is probably very close

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to $k = 1$. The values of W and $\frac{e}{d}$ are very unsteady in this region, because the tension flange is affected so greatly by a small change in the position of the neutral axis. Inasmuch as $k =$ nearly 1, $\frac{e}{d} = 0.939$ corresponds to an $\frac{e\,k}{d}$ of nearly 0.939, and, by further trial, it is found that $\frac{W}{A\,f_c} = 0.40$. Hence these columns will fail at a load of 35 000 $\times$ 0.40 = 14 000 lb. per sq. in., and the factor of safety will be $\frac{14\,000}{5\,460}$, or 2.56.

The slenderness ratio of these columns (if they are considered as rigidly held for sidewise deflection) is only $\frac{360}{3.6} = 100$, and yet a stress of only 5 430 lb. per sq. in. produced as low a factor of safety as 2.5 in steel having a U. L. P. of 35 000 lb. A careful analysis of the condition under which a column is loaded, therefore, is of vital importance in its design, especially when the factors of safety are as low as the Committee states. The example chosen is not so rare in practice as it may appear; such cases occur in theater construction and garages, also in railroad crossings in the large cities.

This theory allows also a clearer conception of the behavior of latticed columns. On account of the final eccentricity of the column as a whole, the stresses in the dangerous section will be unequally distributed, and the magnitude of these stresses can be found from the values of k in the tables. According to whether the column is truly hinge-ended or flat-ended, there exist sections, either at the top or at the quarter points, where the average stresses are equal in magnitude on both sides; and, between these points, the difference of the load on the separate members must be transmitted by the lacing. This transmission of the shears is not uniformly distributed, however; it is greatest near the ends or at the points of inflection.

In regard to the column strength of a latticed column, it must be considered that the eccentricity, e, of the column as a whole, is diminished as the square of the inverse ratio of column length to panel length for each panel, and to this eccentricity must be added the $\frac{e\,k}{d}$ of the separate members between the latticing. There are quite a number of fine points to be considered, and these must be proved by tests, before a definite theory of latticed columns can be established.

MEMOIRS OF DECEASED MEMBERS

NOTE.—Memoirs will be reproduced in the volumes of *Transactions*. Any information which will amplify the records as here printed, or correct any errors, should be forwarded to the Secretary prior to the final publication.

AUGUSTUS MORDECAI, M. Am. Soc. C. E.*

DIED JULY 28TH, 1918.

Augustus Mordecai, son of the late Maj. Alfred Mordecai and Sara Hays Mordecai, was born in Philadelphia, Pa., on September 8th, 1847.

He attended the Polytechnic College of Pennsylvania, from which he was graduated in June, 1866, and then, for about a year, served as a Rodman on the construction of the Dutchess and Columbia Railroad, now a part of the Central New England System.

During the next four years Mr. Mordecai was in charge of construction divisions, successively, on the Connecticut Western Railroad (now also a part of the Central New England System), on the St. Louis, Council Bluffs, and Omaha Railroad (now a part of the Missouri Pacific System), and on the Pittsburgh, Virginia, and Charleston Railroad (now a part of the Pennsylvania System), remaining on each work until its completion.

In 1872, Mr. Mordecai went to Cleveland, Ohio, as Division Engineer in charge of maintenance on the Atlantic and Great Western Railroad, which was afterward merged into the present Erie Railroad System. For twenty years he remained in Cleveland, associated with the Erie road and its successors, filling the positions, successively, of Division Engineer, Resident Engineer, and General Roadmaster. In 1892, he was appointed Chief Engineer of the Erie System, with headquarters in New York City, and served in that capacity until 1896. For ten years thereafter he resided in Cleveland as Assistant Chief Engineer in charge of construction and maintenance on all the lines of the Erie System from Salamanca to Chicago, and was then appointed Chief Engineer of the Lorain and Ashland Railroad, in charge of the location and construction of that line. He was afterward associated with J. F. Stevens, M. Am. Soc. C. E., as Office Engineer in the valuation of the New York, New Haven, and Hartford Railroad, until the completion of that work.

From 1909, Mr. Mordecai was active in Cleveland as a Consulting Engineer, notably in connection with the Belt Line around Cleveland, and with valuations of the properties of the New York Central, the New York, New Haven, and Hartford, the Lehigh Valley, and the Canadian Pacific Railroad Companies, and also the Detroit United

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* Memoir prepared by John C. Trautwine, Jr., Assoc. Am. Soc. C. E.

Street Railway Company. Up to the time of his fatal illness, he was engaged in similar work for the Erie Railroad Company. In 1912, he was appointed, by the Mayor of Cleveland, a member of that city's River and Harbor Commission.

In Cleveland, on October 14th, 1897, Mr. Mordecai was married to Miss Margaret Bowman, who survives him.

Mr. Mordecai's kindly and unassuming nature, his sterling integrity, and his fine sense of humor endeared him to all who had the good fortune to know him.

Mr. Mordecai became a Member of the American Railway Engineering Association in 1909, and was one of the original members of the Cleveland Engineering Society. He was elected a Member of the American Society of Civil Engineers on February 1st, 1893, and served as a Director for the period 1895-97.

PAPERS AND DISCUSSIONS CURRENT IN PROCEEDINGS

"Cement Joints for Cast-Iron Water Mains." Clark H. Shaw..................Mar., 1917
Discussion..May, Aug., "

Progress Report of the Special Committee to Codify Present Practice on the Bearing Value of Soils for Foundations, etc..........................Aug., "
Discussion..Nov., "

Final Report of the Special Committee on Steel Columns and Struts.......Dec., "
Discussion................................Feb., Mar., Apr. Aug., Oct., 1918

Progress Report of the Special Committee on the Regulation of Water Rights. Dec., 1917
Discussion..Feb., 1918

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Discussion...Mar., May, Aug., "

"Determination of the Duty of Water by Analytical Experiment." W. C. Hammatt..Feb., "
Discussion...Apr., Oct., "

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"Construction Methods Used in Building the Lower Reservoir Dam of the Balmorhea Project." Vernon L. Sullivan..............................Apr., "

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PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

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The Reading Room of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

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* Appointed Director, October 8th, 1918, to fill the vacancy caused by the death of William R. Hill, M. Am. Soc. C. E.

Vol. XLIV. NOVEMBER, 1918. No. 9.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PROCEEDINGS

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MINUTES OF MEETINGS

OF THE SOCIETY

October 16th, 1918.—The meeting was called to order at 8.30 P. M.; Vice-President Kittredge in the chair; Chas. Warren Hunt, Secretary; and present, also, 185 members and guests.

Maj. C. Raymond Hulsart, Engineers, U. S. A., Assoc. M. Am. Soc. C. E., recently returned from France, gave a description of the work of the "Eleventh Engineers in France", and the general and special training of engineer officers and troops, illustrating his remarks with lantern slides and moving pictures.

The Secretary annnounced the election of the following candidates on October 8th, 1918:

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TSU CHANG KWAN, Hong Kong, China
HUNG HSUN LING, New York City
GEORGE EDMUND LYON, Schaghticoke, N. Y.
LLOYD LITTELL MARTIN, Franklin, N. Y.
CHARLES BAILEY RICHARD, Brooklyn, N. Y.
CURLIS ROBERTS, Bluefield, W. Va.
MARVIN WATTERSON THOMAS, Dallas, Tex.
ALBERT PAUL TRESER, New Castle, Pa.

The Secretary announced the transfer of the following candidates on October 8th, 1918:

FROM ASSOCIATE MEMBER TO MEMBER

CLARE HARMON CURRIE, Webster City, Iowa
ALLEN DOUGLAS DUCK, Greenville, Tex.
HERBERT WATSON HATTON, Wilmington, Del.
HAROLD VINCENT JOSLIN, Washington, D. C.
FREDERICK WILLIAM LYON, Pittsburgh, Pa.
FRANK SNOW PARRIGIN, Panama City, Fla.
FRED MORSE RANDLETT, Portland, Ore.
CLEMENT CLARENCE WILLIAMS, Nitro, W. Va.
JOSEPH JOHNSON YATES, New York City

FROM JUNIOR TO MEMBER

HARRY LEE VAN ZILE, Am. Exp. Forces, France

FROM JUNIOR TO ASSOCIATE MEMBER

DONALD HILARY CONNOLLY, Greenville, S. C.
WALTER RHODES DRURY, Ann Arbor, Mich.
GEORGE JOSEPH FISHER, Camp Lee, Va.
WILLIAM HAWLEY FRANKLIN, Seattle, Wash.
GEORGE CORLISS ILLINGWORTH, Cincinnati, Ohio
FRANCIS WHITTIER JOHNSON, Philadelphia, Pa.
OLIVER CROMWELL LISMAN, Camp Devens, Mass.
GEORGE EARL MARTIN, Am. Exp. Forces, France
FREDERICK OHRT, Honolulu, Hawaii
RICHARD BENNETT SMITH, Am. Exp. Forces, France
HAROLD ANTHONY SWEETLAND, Bristol, Pa.

The Secretary announced the following deaths:

James Murray Africa, of Huntingdon, Pa., elected Member, September 2d, 1896; died September 18th, 1918.

Andrew Bryson, of New Castle, Del., elected Member, April 1st, 1885; died October 1st, 1918.

James Hayward Harlow, of Darlington, Md., elected Member, March 4th, 1874; died October 6th, 1918.

Julius Lilien Jacobs, of Norfolk, Va., elected Junior, September 1st, 1908; Associate Member, February 28th, 1911; Member, March 2d, 1915; died October 2d, 1918.

John Hull Decker, of Atlantic City, N. J., elected Junior, September 6th, 1904; Associate Member, December 5th, 1906; died October 10th, 1918.

Ogden Merrill, of New York City, elected Associate Member, February 3d, 1904; died October 5th, 1918.

William Arthur O'Brien, of Cape Girardeau, Mo., elected Associate Member, January 2d, 1912; died October 12th, 1918.

Clarence J. Rannells, of Rochester, Ind., elected Associate Member, October 3d, 1906; date of death unknown.

Harry Arthur Weeks, of Albany, N. Y., elected Associate Member, April 4th, 1911; died September 22d, 1918.

Clifton L'Orignal Weekes, of Cincinnati, Ohio, elected Junior, October 9th, 1917; died October 8th, 1918.

Adjourned.

November 6th, 1918.—The meeting was called to order at 8:30 p. m.; O. E. Hovey, M. Am. Soc. C. E., in the chair; Chas. Warren Hunt, Secretary; and present, also, 170 members and guests.

The minutes of the meetings of September 18th and October 2d, 1918, were approved as printed in *Proceedings* for October, 1918.

Mr. Charles N. Kight, Special Representative of the U. S. Aero Mail Division, addressed the meeting on the problems of the U. S. Postal Department in establishing the Aerial Mail Service between New York and Philadelphia, Washington, Chicago, and other cities.

Mr. G. Douglas Wardrop, Editor of *Aerial Age,* recently returned from the front, gave a talk on "A Trip to Germany by the Air Route", illustrating his remarks with lantern slides.

The Secretary announced the following deaths:

Clarence Coleman, of Duluth, Minn., elected Member, November 3d, 1897; died October 23d, 1918.

Hunter McClure, 1st Lieut., Engrs., U. S. A., of Piedmont, Cal., elected Junior, January 4th, 1910; Associate Member, October 9th, 1917; died in service (France), September 26th, 1918.

William Menke, of Athens, N. Y., elected Junior, December 6th, 1910; Associate Member, April 16th, 1918; died November 1st, 1918.

James Powell Murray, of Austin, Tex., elected Associate Member, November 28th, 1916; died September 28th, 1918.

Edward Porter Alexander, 1st Lieut., Engrs., U. S. A., of Duluth, Minn., elected Junior, November 4th, 1914; died in service (France), September 5th, 1918.

Richard Jeter Palmer, Jr., of Norfolk, Va., elected Junior, October 10th, 1916; died October 13th, 1918.

Kirby Baldwin Sleppy, Capt., 4th Engrs., U. S. A., of Los Angeles, Cal., elected Junior, December 3d, 1912; killed in action in France.

Adjourned.

OF THE BOARD OF DIRECTION

(Abstract)

October 8th, 1918.—The Board met at 10.05 A. M.; President Talbot in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Alvord, Darling, Davis, Duryea, Fay, Flinn, Humphreys, A. M. Hunt, Ketchum, Khuen, Lewis, Noble, Pegram, Rights, Wagner, and Wall.

Appropriations for the calendar year 1919, for the Library Board, $4 000, and for Engineering Council, $4 000 from each of the Founder Societies, were approved in behalf of this Society.

On motion, duly seconded, the following resolution was unanimously adopted:

"*Whereas,* Engineering Council at a meeting held on June 20, 1918, adopted a resolution expressing the belief that the Founder Societies can deal more effectively with the matter of employment than can Engineering Council,

"*Resolved,* That the Board of Direction of the American Society of Civil Engineers recommends that the Secretaries of the four Founder Societies, subject to the approval of their respective governing bodies, be constituted a committee on Engineering Employment, such committee to report to Engineering Council, which body will be able to perform certain functions, especially those relating to publicity, which cannot be consistently performed by the Founder Societies.

"*Resolved,* That a copy of this resolution be sent to the governing bodies of the three other Founder Societies for their consideration and to Engineering Council."

The Secretary presented a general report explaining that the Publication Committee had been unable to hold a meeting, and that the matter had been somewhat informally brought to the attention of the Finance Committee. After discussion it was resolved that the publication of the usual volume of *Transactions* for the year 1919 be postponed, and the Secretary was instructed to make a general statement as to the reasons governing the Board in this action when the action is published.*

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* See page 996.

A report from the Committee on Special Committees, to whom was referred suggestions as to the appointment of a Special Committee on Completing the Map of the United States, was received, stating that the Committee has "considered the matter, and while realizing the importance both from Military and Civil standpoints of an early completion of this work, believe it inexpedient at this time to appoint such a committee due to the greater problems now before the country. The Committee believe that after the war such a committee could be profitably appointed to urge the completion of this work. The Committee on Special Committees therefore recommend that no action be taken at this time." This Report was received and its recommendations adopted.

A report was received from the Committee of the Board on the General Policy of the Society with regard to the Approval of Standards of all Kinds, stating that, as its work might be a duplication of that of the Committee on Development subsequently appointed, that it be discharged. The Committee was discharged as requested.

The Secretary reported in regard to the Fifty-seventh Street property of the Society. A Report signed by members of the Executive Committee had already been forwarded to each member of the Board relating to the action taken in regard to the Society property.

The Secretary stated that an agreement had been effected with the Ajax Rubber Company, Inc., a New York Corporation, to take a lease of premises known as No. 220 West 57th Street for a term of ten years from the date of the completion of certain alterations which are now in process of construction and which would probably be completed about December 15th, 1918, the amount of the rental to be $18 000 per annum, payable in monthly installments in advance, plus an additional annual rental of an amount equal to 7% on the sum to be expended by the Society in making alterations to the building. The Secretary further stated that plans had been prepared by Arnold Brunner, Esq., the architect for the Society, for these alterations, all of which had been done pursuant to the general authority heretofore conferred upon the officers of the Society. He suggested that, in accordance with the provisions of the Membership Corporations Law, the approval of the Board of Direction for this proposed lease should be given, and that a resolution for such approval had been prepared by Messrs. Parker and Aaron, Counsel for the Society.

Thereupon, on motion duly seconded, the following resolution was adopted unanimously by the vote of all the Trustees present, being more than a majority of the whole number of its Trustees, which is thirty:

Resolved, that the Trustees of the American Society of Civil Engineers do hereby authorize and direct that a lease be made of the real property of the Society known as No. 220 West 57th Street for a term of ten (10) years to begin at the completion of the alterations now being made to the building, at the annual rental of Eighteen Thousand Dollars ($18 000), plus an additional rental equal to seven per cent. (7%) of the amount expended by the Society in making alterations to the building for the benefit of the tenant; the tenant in addition to pay taxes, water rates and assessments during the term of the lease; said lease to be made to the Ajax Rubber Company, Inc.

Further Resolved, that the President and Secretary of this Society be authorized and ordered to execute, on behalf of the American Society of Civil Engineers, a lease of the said premises to the said Ajax Rubber Company, Inc., for said term at said rental, containing such usual provisions and conditions as shall be satisfactory to the Counsel of the Society.

John A. O'Connor was unanimously appointed to fill the vacancy in the Board of Direction caused by the death of William R. Hill.

The report of the Nominating Committee for the offices to be filled on January 15th, 1919, was received, and the Secretary was authorized to forward the names of the nominees to the membership, as directed by the Constitution.*

The President was authorized to appoint tellers to canvass the Ballot for Officers at the Annual Meeting.

The President was also authorized to appoint a Committee to canvass both Preliminary and Final Suggestions for Members of the Nominating Committee.

A sum not to exceed $1 000 was appropriated for the use of the Committee on Development for clerical and general expenses; and mileage at the rate of five cents per mile was authorized for the first meeting of the Committee.

Ulysses B. Hough, M. Am. Soc. C. E., was appointed to fill the vacancy on the Nominating Committee caused by the resignation of Maj. Joseph Jacobs as representative of District No. 12.

The Secretary reported he had transmitted the resolution adopted by the Board at its June meeting with regard to visits to the Local Associations, and that replies had been received from the Seattle, Duluth, Cleveland, Portland, Ore., and Illinois Associations, expressing approval of the plan.

The resolution adopted at the September 4th, 1918, Society Meeting† was considered, together with a letter from Messrs. Robert Ridgway, Arthur S. Tuttle, and Frederick C. Noble, who originated the matter, and the President was authorized to appoint a Committee of five for the purpose of keeping the Board informed as to the formulation of plans for the rehabilitation of the Engineering resources of the country after the close of the war.

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* See page 891.

† See page 784.

The following resolutions, adopted by Engineering Foundation, were presented for the consideration of the Board, and on motion, duly seconded, the Board concurred in the project:

"*Survey of Engineering Organizations.*

"*Be It Resolved:* That the Engineering Foundation is prepared, the four Founder Societies concurring, to devote its strength and its income, so far as this may be required, to a study of existing engineering organizations, and from information thus developed to formulate a series of constructive recommendations which may be serviceable in guiding the further development of local and national engineering organizations in their relations to the profession of engineering, to the public and to each other, to the end that a foundation may be laid upon which to establish a broadly planned procedure, which, while recognizing and preserving all that has already been acccomplished, shall increase the power of American engineers in upbuilding their profession and in the service they render to society; and

"*Resolved:* That in accepting the responsibility for such an undertaking, it will be the purpose of the Engineering Foundation to organize the proposed research along the broadest possible lines, to call to its aid highly qualified experts, and to avail itself of the help of agencies which may be willing to co-operate; and

"*Resolved:* That in proposing this research, the Engineering Foundation Board has no desire or purpose to intrude upon the domain of individual organizations; that it does not propose to control the action of any individual or organization; nor to ask the acceptance of its conclusions; but that its purpose shall be to develop a possible procedure, or a series of such procedures, of such evident merit that they will appeal to those who are likely to be most interested; it will do this in the belief that, in so far as its work may justify the confidence of engineers and of engineering organizations, it will bear its own fruitage."

J. V. Davies was re-elected as one of the representatives of the Society on the United Engineering Society for one term of three years, his present term expiring January 23d, 1919.

Arthur N. Talbot was appointed as one of the Society's representatives on the John Fritz Medal Board of Award, to take the place of Chas. Warren Hunt, whose term expires at the next Annual Meeting of the John Fritz Medal Board of Award, January, 1919.

The following Societies were unanimously approved by the Board as additional members of Engineering Council: Western Society of Engineers, Society of Automotive Engineers, Inc., and the American Society for Testing Materials.

On motion, duly seconded, Vice-President Kittredge was authorized to appoint a Committee to arrange for the 1919 Annual Meeting.*

Attention was called to the fact that, as no Convention was held this year, the President had not made the Annual Address, and on motion, duly seconded and adopted, the President was requested to make his Annual Address to the Anuual Meeting in January.

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* For names of Annual Meeting Committee, see p. 999.

The Secretary reported that Mr. Ambrose Swasey had made an additional gift to Engineering Foundation of $100 000, supplementing his original gift of $200 000, and on motion, duly seconded, was authorized to write to Mr. Swasey expressing the deep appreciation of the Board for this gift.

The resignations of one Member, one Associate, and one Associate Member were accepted.

Ballots for membership were canvassed, resulting in the election of 12 Members, 36 Associate Members, 2 Associates, and 12 Juniors, and the transfer of 1 Junior to the grade of Member, and 11 Juniors to the grade of Associate Member.

Nine Associate Members were transferred to the grade of Associate Member.

Applications were considered and other routine business transacted.

Adjourned.

The Board reconvened at 11.29 P. M., October 8th, 1918; President Talbot in the chair; Chas. Warren Hunt, Secretary, and present, also, Messrs. Darling, Davis, Duryea, Fay, Flinn, A. M. Hunt, Khuen, Lewis, Noble, and Wall.

A report from the Membership Committee was received and acted upon.

Adjourned.

SOCIETY ITEMS OF INTEREST

Ambrose Swasey's Second Gift to Engineering Foundation

Ambrose Swasey, Past-President, Am. Soc. Mech. Engineers, has recently presented to The Engineering Foundation the sum of $100 000, his second large gift to the fund "devoted to the advancement of the Engineering Arts and Sciences in all their branches, to the greatest good of the Engineering Profession, and to the benefit of Mankind."

The Engineering Foundation was started by Mr. Swasey's first gift of $200 000, in 1915, the inaugural meeting having been held on January 27th of that year. The fund is in the custody of The United Engineering Society, and is administered by a Board consisting of two representatives elected by each of the four National Engineering Societies, the President of the United Engineering Society, *ex officio,* and two members elected at large.

Mr. Swasey's gifts have enabled the Engineering Foundation to co-operate with the National Academy of Sciences by establishing the National Research Council, thus bringing together Governmental, educational, industrial, and other research agencies in the interest of the National defense.

Publications

At its meeting of October 8th, 1918, the Board of Direction voted that no volume of *Transactions* should be issued during 1919. The number of technical papers and discussions to be published in *Proceedings* was left to the discretion of the Committee on Publications.

The Committee, subsequently, after most careful consideration, thought it wise to abandon the publication of all technical matter temporarily, as a war economy.

There are several reasons for this decision which may be stated briefly:

(1) Due to the scarcity of all kinds of paper, the Government has ordered its conservation in every direction, having gone so far as to prohibit the issue of exchanges and free copies of periodicals.

(2) The cost of the paper used in *Proceedings,* including the plate paper and mailing envelopes, has increased almost 100%, and it is now impossible to obtain the imported Bible paper used in the volumes of *Transactions.*

(3) Practically 25% of the entire membership of the Society is either serving in the armies and navies of the United States and its Allies or engaged in work in connection with the war, and is therefore too busy to discuss, or perhaps even to read, technical papers. The necessary postponement of the publication of valuable technical papers will not detract from their ultimate usefulness, especially as

when they are finally published many members now engrossed in war work will be able to give attention to their study and discussion.

(4) Financial: A careful estimate shows that, on the basis of continuing activities on the same scale as heretofore, the Society will be very close to a deficit at the end of 1919, so that the necessity of economy is apparent. Various factors have contributed to this condition. During 1917 the Society moved to its new Headquarters in the Engineering Societies Building, and the unexpected increase in the expense of building and of moving, due entirely to war conditions which could not be foreseen, has been a severe drain on its finances. Had it been possible to sell or lease the Fifty-seventh Street property promptly, this condition would have been ameliorated.

(5) More than 1 400 members of the Society who are in the Service, have been exempted from the payment of dues for the duration of the war or their terms of service, and these exemptions have greatly decreased receipts for the present year.

The publication of *Proceedings* will be continued. Regular meetings of the Society will also be continued. As far as possible, these meetings will be devoted to the presentation and discussion of topics of work having a direct bearing on war work. Should matter of interest to the membership be developed, it will be published in *Proceedings*.

Publications of the International Engineering Congress of 1904

The Society has in stock a number of extra copies of the papers presented at the International Engineering Congress of 1904 for which it can no longer provide storage space. For the next 30 days, or until December 31st, 1918, these papers will be given free to members of the Society if they will indicate which ones they want, the only charge being for the necessary cost of forwarding. As this will vary for the several publications and for forwarding to the various postal zones, it cannot be stated in advance, but will be charged to the account of each member to whom these papers are forwarded.

The papers, with discussion thereon, are collated under the various subject headings, and are bound in paper covers. The following is a list of the subjects and the number of papers collated under each:

The Purification of Water for the Production of Steam. 1 paper, with discussion.
Fortifications. 1 paper.
Live Loads for Railroad Bridges. 1 paper, with discussion.
Mining Engineering. 2 papers, with discussion.
Harbors. 10 papers, with discussion.
Engineering Education. 2 papers, with discussion.
Light-Houses and Other Aids to Navigation. 3 papers, with discussion.
The Manufacture of Cement. 1 paper, with discussion.
Passenger Elevators. 1 paper, with discussion.
Ordnance. 5 papers, with discussion.
Surveying. 2 papers, with discussion.
The Concurrent Development of Traffic on Improved Waterways and on Railroads. 1 paper, with discussion.
Irrigation. 5 papers, with discussion.
Marine Engineering. 2 papers, with discussion.
Dredges: Their Construction and Performance. 5 papers, with discussion.
Ventilation of Tunnels. 2 papers, with discussion.
Naval Architecture. 3 papers, with discussion.
Purification of Water for Domestic Use. 4 papers, with discussion.
Locomotives and Other Rolling Stock. 3 papers, with discussion.

ELECTRICAL POWER-GENERATING STATIONS AND TRANSMISSION. 1 paper, with discussion.
NATURAL WATERWAYS. 2 papers, with discussion.
PUMPING MACHINERY. 2 papers, with discussion.
THE SUBSTITUTION OF ELECTRICITY FOR STEAM AS A MOTIVE POWER. 2 papers, with discussion.
STEAM TURBINES. 1 paper, with discussion.
DEEP FOUNDATIONS. 1 paper, with discussion.
SEWAGE DISPOSAL. 2 papers, with discussion.
DISPOSAL OF MUNICIPAL REFUSE. 2 papers, with discussion.
THE MANUFACTURE OF STEEL. 2 papers, with discussion.
CONCRETE AND CONCRETE-STEEL. 5 papers, with discussion.
WHARVES AND PIERS. 1 paper, with discussion.
TESTS OF MATERIALS OF CONSTRUCTION. 5 papers, with discussion.
HIGHWAY CONSTRUCTION. 3 papers, with discussion.
ARTIFICIAL WATERWAYS. 4 papers, with discussion.
UNDERGROUND RAILWAYS. 3 papers, with discussion.
DRY DOCKS. 3 papers, with discussion.
RAILROAD TERMINALS. 3 papers, with discussion.

Applications for copies of these papers should be made promptly, as this offer will remain open only until December 31st, 1918.

ANNOUNCEMENTS

The Reading Room of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

FUTURE MEETINGS

December 4th and 18th, 1918.—8.30 P. M.—Meetings will be held as usual on these evenings, that of December 4th being the regular business meeting of the Society. The arrangements for the second meeting are in the hands of the New York Meetings Committee, and programmes for both meetings will be announced later.

ANNUAL MEETING

The Sixty-sixth Annual Meeting will be held at the Headquarters of the Society, 33 West 39th Street, New York City, on Wednesday and Thursday, January 15th and 16th, 1918.

COMMITTEE OF ARRANGEMENTS

W. W. BRUSH, *Chairman,*
F. S. CROWELL,
J. DEB. W. GARDINER,
T. C. DESMOND,
ALEX. HARING,
CHAS. WARREN HUNT.

The Business Meeting will be called to order at 10 o'clock on Wednesday morning. The Annual Reports will be presented, Officers for the ensuing year elected, members of the Nominating Committee appointed, Reports of Special Committees presented for discussion, and other business transacted.

SEARCHES IN THE LIBRARY

In January, 1902, the Secretary was authorized to make searches in the Library, upon request, and to charge therefor the actual cost to the Society for the extra work required. Since that time many searches have been made, and bibliographies and other information on special subjects furnished.

The resulting satisfaction to the members who have made use of the resources of the Society in this manner has been expressed frequently, and leaves little doubt that if it were generally known to engineers that such assistance could be had, many would avail themselves of it.

On October 1st, 1916, the Library of the American Society of Civil Engineers ceased to exist as such, and was merged in the Engineering Societies Library, adding 67 000 volumes to the collection, which comprises also the former libraries of the American Institute of Mining Engineers, the American Society of Mechanical Engineers, and the

American Institute of Electrical Engineers, and now has a total of 133 000 volumes and pamphlets. Containing, as the Library now does, the special collections mentioned, its scope is broadened, and, as it receives an unusually large number of technical periodicals, it is well equipped to continue the service formerly rendered by the Society Library.

The Engineering Societies Library offers this service at a cost which is trifling compared with the value of the time of an engineer who personally looks up such matters, and the work can be performed quite as well, and much more quickly, by persons familiar with the Library.

In asking that such work be undertaken, members should specify clearly the subject to be covered, and whether references to general books only are desired, or whether a complete bibliography, involving search through periodical literature, is desired.

It sometimes happens that references are found which are not readily accessible to the person for whom the search is made. In that case the Library is prepared to furnish photographic copies of the material at a small price per page. This method is particularly useful when there are drawings or figures in the text, which would be very expensive to reproduce by hand.

The Library is also able to provide translations of articles in foreign languages when desired.

Requests for searches, copies, translations, etc., should be addressed to the Director, Engineering Societies Library, 29 West 39th Street, New York City, who will gladly give information concerning the charges for the various kinds of service.

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association, Organized 1905.

Jerome Newman, President; Nathan A. Bowers, Secretary-Treasurer, 502 Rialto Building, San Francisco, Cal.

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet, and weekly informal luncheons. The former are held at 6 P. M., at the Palace Hotel, on the third Tuesday of February, April, June, August, October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at noon, every Wednesday, at the Engineers' Club, 57 Post Street, where special tables are reserved for members and guests of the Association.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest.

Colorado Association, Organized 1908.

L. R. Hinman, President; A. N. Miller, Secretary-Treasurer, 1400 West Colfax Avenue, Denver, Colo.

The meetings of the Colorado Association of Members of the American Society of Civil Engineers (Denver, Colo.) are held on the second Saturday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary. The meetings are usually preceded by an informal dinner. Members of the American Society of Civil Engineers will be welcomed at these meetings.

Weekly luncheons are held on Wednesday at 12.30 P. M., at Daniels and Fisher's.

Visiting members are urged to attend the meetings and luncheons.

Atlanta Association, Organized 1912.

B. M. Hall, President; Thomas P. Branch, Secretary-Treasurer, Georgia School of Technology, Atlanta, Ga.

Informal luncheons are held for members of the Association on the last Monday of each month, at 12.30 P. M.

Baltimore Association, Organized 1914.

H. G. Perring, President; Charles J. Tilden, Secretary-Treasurer, The Johns Hopkins University, Baltimore, Md.

Cleveland Association, Organized 1914.

Harry Fuller, President; George H. Tinker, Secretary-Treasurer, 516 Columbia Building, Cleveland, Ohio.

Detroit Association, Organized 1916.

T. A. Leisen, President; Clarence W. Hubbell, Secretary, 2348 Penobscot Building, Detroit, Mich.

The regular meetings of the Association are held on the second Friday of December, April, and October, the last being the Annual Meeting.

District of Columbia Association, Organized 1916.

A. P. Davis, President; John C. Hoyt, Secretary-Treasurer, U. S. Geological Survey, Washington, D. C.

Duluth Association, Organized 1917.

W. B. Patton, President; Walter G. Zimmermann, Secretary, Wolvin Building, Duluth, Minn.

The regular meetings of the Association are held at noon on the third Monday of each month (usually at the Kitchi Gammi Club), with luncheon, followed by a short business session and the reading of papers. Visiting members of the American Society of Civil Engineers can secure from the Secretary definite information relative to the meetings, at which they will be welcomed. The Annual Meeting is held on the third Monday in May.

Illinois Association, Organized 1916.

A. S. Baldwin, President; Edgar S. Nethercut, Secretary-Treasurer, 1735 Monadnock Blk., Chicago, Ill.

The regular meetings of the Association are held on the second Monday of March, June, September, and December, the last being the Annual Meeting. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary.

Louisiana Association, Organized 1914.

Arsene Perrilliat, President; Eugene F. Delery, Secretary, 2007 Laharpe St., New Orleans, La.

The regular meetings of the Association are held at The Cabildo, New Orleans, La., on the first Monday of January, April, July, and October.

Nebraska Association, Organized 1917.

George L. Campen, President; Homer V. Knouse, Secretary-Treasurer, 109 City Hall, Omaha, Nebr.

Regular meetings of the Association are held on the first Saturday of each month, except July and August, and at such places as may be appointed from time to time by the Executive Committee. The Annual Meeting is held in Lincoln, Nebr., on the second Friday in January.

An "Engineers' Round Table" is reserved daily for luncheon, at Courtenay's Restaurant, 17th and Douglas Streets, Omaha, to which all engineers are invited. Visiting members of the Society are especially urged to communicate with the Secretary when in the city.

Northwestern Association, Organized 1914.

P. E. Thian, President; Ralph D. Thomas, Secretary, Care, St. Anthony Falls Water Power Co. and Minneapolis Mill Co., Minneapolis, Minn.

The meetings of the Association are held bi-monthly, alternating between St. Paul and Minneapolis, on the third Friday of each month. Information as to the time and place of such meetings will be furnished on application to the Secretary.

Philadelphia Association, Organized 1913.

Henry H. Quimby, President; C. W. Thorn, Secretary, Crum Lynne, Pa.

The regular meetings of the Association are held at the Engineers' Club of Philadelphia, 1317 Spruce Street, on the first Monday in January, April, and October, the last being the Annual Meeting.

Pittsburgh Association, Organized 1917.

Richard Khuen, Jr., President; John D. Stevenson, Secretary-Treasurer, 1231 Monterey St., Pittsburgh, Pa.

The Annual Meeting of the Association is held on the first Monday in October. The time and place of other meetings are not fixed, but this information will be furnished on application to the Secretary.

Portland, Ore., Association, Organized 1913.

Philip H. Dater, President; C. P. Keyser, Secretary, 318 City Hall, Portland, Ore.

St. Louis Association, Organized 1888 (Constitution Approved by Board, 1914).

J. A. Ockerson, President; C. M. Daily, Secretary-Treasurer, 4240 Shaw Avenue, St. Louis, Mo.

The Annual Meeting of the Association for the election of officers and for the transaction of business, is held on the fourth Monday in November. Two meetings each year, for the presentation and discussion of technical papers, are held in the Auditorium of the Engineers Club of St. Louis and are open to members of the Associated Societies. Other "get-together" meetings are held regularly for dinner or luncheon on the fourth Monday of each month except July, August, and November.

(Abstract of Minutes of Meetings)

September 23d, 1918.—The meeting was called to order; President Ockerson in the chair; C. M. Daily, Secretary; and present, also, 15 members.

The minutes of the meeting of July 1st, 1918, were read and approved.

The Secretary read a letter from Capt. W. B. Hall, requesting information for the use of the Historical Data Section of the Engineering Corps regarding the publicity method used in securing officers and enlisted men for the Special Engineering Troops. The Secretary was directed to reply that the St. Louis Association was not requested to do any publicity work; also, that a committee had been sent to St. Louis by the Engineering Department for that purpose, and, further, that the Association was ready to co-operate with that Department.

The President stated the purpose of this meeting, namely, to discuss the Resolutions, passed recently by the Board of Direction, providing for the creation of the Development Committee, to report on "the purposes, field of work, scope of activity and usefulness, organization, and methods of work of the American Society of Civil Engineers", etc. He stated, further, that the meeting could be considered as a preliminary skirmish, and that a free and informal discussion was invited.

Mr. Baxter L. Brown, the Association's representative on the Development Committee, presented a list of twelve topics, commenting on each one. The topics are as follows:

1.—Creation of U. S. Department of Public Works.
2—Issuance of publications containing matters of interest to engineers other than strictly technical papers, preferably to be issued jointly by the National Societies.
3.—Employment Bureau.
4.—Licensing of engineers.
5.—Unification of the National Societies.
6.—Sub-committees of Local Associations.

7.—Amendment of the Constitution.
8.—Organization in large cities of all engineers on the principle of the St. Louis Associated Engineering Society.
9.—Code of ethics.
10.—Elimination of the Secretary of the Society from the Board of Direction.
11.—Transaction of the business of the Society to be conducted more on the "Congressional" than on the "Town Meeting" plan.
12.—Arbitration committee in each district.

These topics were discussed separately.

On motion, duly seconded, the President was authorized to appoint a committee of three to investigate and report at the next meeting on the necessary procedure for the enaction, by the State Legislature, of a law for licensing civil engineers.

Adjourned.

October 28th, 1918.—The meeting was called to order; President Ockerson in the chair; C. M. Daily, Secretary; and present, also, 23 members.

The minutes of the meeting of September 23d, 1918, were read and approved.

Mr. Baxter L. Brown, of the Committee on Development, read a letter from a member of that Committee from Los Angeles, Cal., and spoke at length on what had been done in the way of exchanging views with the members.

The Committee on Licensing Engineers made the following report:

> "Your Committee appointed to report on necessary proceedings to be taken by the Association to have a law enacted by the State Legislature to license Civil Engineers to practice the profession in the State of Missouri, have to report:
>
> "That in view of the fact that the National Council of Engineers has taken the matter in hand with the view to securing a comprehensive Federal law on the subject, covering all branches of engineering, it would not, in the opinion of the Committee, be advisable for this Association to take action at this time, but await the result of the Council's action."

On motion, duly seconded, the report was adopted.

On motion, duly seconded, the President was authorized to appoint a committee to nominate officers of the Association for the annual election on November 25th, 1918. Messrs. W. G. Brenneke, W. A. Horner, and J. E. Allison were appointed and instructed to report not later than November 15th, 1918.

Adjourned.

San Diego Association, Organized 1915.

N. B. Kellogg, President; P. R. Watson, Secretary-Treasurer, *pro tem.*, County Engineer's Office, San Diego, Cal.

Seattle Association, Organized 1913.

A. S. Downey, President; Phil. A. Franklin, Secretary, 1409 East 65th St., Seattle, Wash.

The regular monthly meetings and luncheons of the Association are held at the Frye Hotel, 3d Avenue and Yesler Way, at 12.15 P. M., on the last Monday of each month. All members, in any grade, of the American Society of Civil Engineers are cordially invited to attend the meetings when in the vicinity.

Southern California Association, Organized 1914.

Louis C. Hill, President; H. W. Dennis, Secretary, Edison Building, Los Angeles, Cal.

The Southern California Association of Members of the American Society of Civil Engineers (Los Angeles, Cal.) holds regular bi-monthly meetings, with banquet, at Hotel Clark, on the second Wednesday of February, April, June, August, October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at 12:15 P. M., every Thursday and the place of meeting may be ascertained from the Secretary.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in Los Angeles, and any such member will be gladly welcomed as a guest at any of the meetings or luncheons.

Spokane Association, Organized 1914.

Peter Mogensen, President; Charles E. Davis, Secretary, City Engineer's Office, Spokane, Wash.

The regular meetings of the Association are held on the second Friday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary.

Visiting members are invited to attend the meetings and luncheons.

Texas Association, Organized 1913.

R. C. Gowdy, President; J. H. Brillhart, Secretary, Care, Mosher Mfg. Co., Dallas, Tex.

Utah Association, Organized 1916.

A. B. Villadsen, President, 304 Dooly Block, Salt Lake City, Utah.

The Annual Meeting of the Association is held on the first Wednesday in April. The time of other meetings is not fixed, but this information will be furnished on application to the President.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcomed by the following Engineering Societies, both to the use of their Reading Rooms, and at all meetings:

American Institute of Electrical Engineers, 25 West Thirty-ninth Street, New York City.

American Institute of Mining Engineers, 25 West Thirty-ninth Street, New York City.

American Society of Mechanical Engineers, 25 West Thirty-ninth Street, New York City.

Asociación de Ingenieros y Arquitectos de Mexico, Avenida Juarez, 12, City of Mexico, Mexico.

Associacão dos Engenheiros Civis Portuguezes, Lisbon, Portugal.

Australasian Institute of Mining Engineers, Melbourne, Victoria, Australia.

Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass.

Brooklyn Engineers' Club, 117 Remsen Street, Brooklyn, N. Y.

Civil Engineers' Society of St. Paul, Public Library, St. Paul, Minn.

Cleveland Engineering Society, Chamber of Commerce Building, Cleveland, Ohio.

Cleveland Institute of Engineers, Middlesbrough, England.

Dansk Ingeniorforening, Amaliegade 38, Copenhagen, Denmark.

Detroit Engineering Society, Detroit Board of Commerce Building, Detroit, Mich.

Engineering Association of Nashville, Commercial Club Building, Nashville, Tenn.

Engineering Association of New South Wales, 5 Elizabeth Street, Sydney, New South Wales, Australia.

Engineering Institute of Canada, 176 Mansfield Street, Montreal, Que., Canada.

Engineering Societies Club of Hawaii, E. F. Cykler, Secretary, Honolulu, Hawaii.

Engineers and Architects Association of Southern California, 405 Hosfield Bldg., Los Angeles, Cal.

Engineers and Architects Club of Louisville, 1412 Starks Building, Louisville, Ky.

Engineers' Club of Baltimore, 6 West Eager Street, Baltimore, Md.

Engineers' Club of Kansas City, Robert S. Beard, Secretary, Third Floor, City Hall, Kansas City, Mo.

Engineers' Club of Minneapolis, 17 South Sixth Street, Minneapolis, Minn.

Engineers' Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa.

Engineers' Club of St. Louis, 3817 Olive Street, St. Louis, Mo.

Engineers' Club of Toronto, 96 King Street, West, Toronto, Ont., Canada.

Engineers' Club of Trenton, Trent Theatre Building, 12 North Warren Street, Trenton, N. J.

Engineers' Society of Northeastern Pennsylvania, 415 Washington Avenue, Scranton, Pa.

Engineers' Society of Pennsylvania, 31 South Front Street, Harrisburg, Pa.

Engineers' Society of Western Pennsylvania, 568 Union Arcade Building, Pittsburgh, Pa.

Florida Engineering Society, J. R. Benton, Secretary, Gainesville, Fla.

Institute of Marine Engineers, The Minories, Tower Hill, London, E., England.

Institution of Civil Engineers, Great George Street, Westminster, S. W., London, England.

Institution of Engineers of the River Plate, Calle 25 de Mayo 195, Buenos Aires, Argentine Republic.

Institution of Mechanical Engineers, 11 Great George Street, London, S. W. 1, England.

Institution of Naval Architects, 5 Adelphi Terrace, London, W. C., England.

Junior Institution of Engineers, 39 Victoria Street, Westminster, S. W., London, England.

Koninklijk Instituut van Ingenieurs, The Hague, The Netherlands.

Louisiana Engineering Society, State Museum Building, Chartres and St. Ann Streets, New Orleans, La.

Memphis Engineers' Club, Memphis, Tenn.

Midland Institute of Mining, Civil and Mechanical Engineers, Sheffield, England.

Montana Society of Engineers, Butte, Mont.

North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, England.

Oregon Society of Civil Engineers, Portland, Ore.

Pacific Northwest Society of Engineers, 803 Central Building, Seattle, Wash.

Rochester Engineering Society, Rochester, N. Y.

Sociedad Colombiana de Ingenieros, Bogota, Colombia.

Sociedad de Ingenieros del Peru, Lima, Peru.

Societe des Ingenieurs Civils de France, 19 rue Blanche, Paris, France.

Society of Engineers, 17 Victoria Street, Westminster, S. W., London, England.

Southwestern Society of Engineers, C. E. Barglebaugh, Secretary, 703 First National Bank Building, El Paso, Tex.

Svenska Teknologforeningen, Brunkebergstorg 18, Stockholm, Sweden.

Tekniske Forening, Vestre Boulevard 18-1, Copenhagen, Denmark.

Vermont Society of Engineers, George A. Reed, Secretary, Montpelier, Vt.

Western Society of Engineers, 1735 Monadnock Block, Chicago, Ill.

ACCESSIONS TO THE ENGINEERING SOCIETIES LIBRARY

(From October 1st to November 1st, 1918)

DONATIONS*

The statements made in these notices are taken from the books themselves, and this Society is not responsible for them.

THE SECOND POWER KINK BOOK:

A Collection of Short Articles from *Power* in Which Practical Men Describe Simple Expedients They have Found Effective in Meeting Every-Day Emergencies in Power-Plant Work. Compiled by the Editorial Staff of *Power*. McGraw-Hill Book Co., Inc., 1918. 11 + 161 pp., 137 illus., 9 x 6 in., ½ cloth. $1.00.

The first "Power Kink Book", published in 1917, has led to requests for a further collection of these notes on emergency power-plant practice, in response to which this volume is issued. The book, like its predecessor, is intended to suggest solutions for unusual problems and methods of meeting difficult situations.

VACUUM TUBES IN WIRELESS COMMUNICATION:

A Practical Textbook for Operators and Experimenters. By Elmer E. Bucher. N. Y., Wireless Press, Inc. (copyright 1918). 174 pp., 219 illus., 9 x 6 in., cloth. $1.75.

The author explains more than one hundred different circuits for the practical use of vacuum tubes, which have been used from time to time in the laboratory and commercial practice, and gives a brief and simple explanation of the manner in which vacuum-tube circuits act.

OPERATOR'S WIRELESS TELEGRAPH AND TELEPHONE HAND-BOOK:

A Complete Treatise on the Construction and Operation of the Wireless Telegraph and Telephone, Including the Rules of Naval Stations, Codes, Abbreviations, etc. By Victor H. Laughter. Chic., Frederick J. Drake & Co. (copyright 1918). 191 pp., illus., 1 pl., 8 x 5 in., cloth. $1.00.

A student's text, in which he is led from a study of simple elementary systems to the more complicated types of wireless telegraph and telephone instruments. Directions for the construction of instruments are given.

THE SUBMARINE IN WAR AND PEACE:

Its Developments and Its Possibilities. By Simon Lake. Phila. and Lond., J. B. Lippincott Co., 1918. 302 pp., 18 illus., 53 pl., 1 por., 1 map, 1 folded diag., 9 x 6 in., cloth. $3.00.

Mr. Lake's endeavor has been to provide an interesting popular account of the mechanical principles of the submarine, the history of its development, its actual operation, the difficulty of combating it, and its industrial possibilities.

A PRACTICAL COURSE IN WOODEN BOAT AND SHIP BUILDING:

The Fundamental Principles and Practical Methods Described in Detail. Especially Written for Carpenters and Other Woodworkers Who Desire to Engage in Boat or Ship Building, and as a Text-Book for Schools. By Richard Van Gaasbeek. Chic., Frederick J. Drake and Co. (copyright 1918). 204 pp., 119 illus., 8 x 5 in., cloth. $1.50.

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*Unless otherwise specified, books in this list have been donated by the publishers.

This textbook is the outgrowth of a course for shipbuilders given at Pratt Institute to assist house carpenters and other woodworkers in transferring from their usual occupations to the shipbuilding industries. The author has attempted to provide a brief, fundamental course in the general principles of construction.

THE SHIPBUILDERS' BLUE BOOK:

Covers Everything on Rivets and Riveting, Spacing of Rivets, Riveting for Water and Oiltight Work, Buttlaps, Buttstraps, Brackets, Frames, Plating etc., by a Practical Man. By Walter Kay Crawford. Edited by E. R. Glass. N. Y. Ocean Publishing Co., 1918. 79 pp., 6 x 4 in., cloth. $1.50.

It is stated that this is a compact manual of information for apprentices and shipfitters. It is largely in tabular form.

STEEL SHIPBUILDER'S HANDBOOK:

An Encyclopedia of the Names of Parts, Tools, Operations, Trades, Abbreviations, etc., Used in the Building of Steel Ships. By C. W. Cook. N. Y. and Lond., Longmans, Green & Co., 1918. 123 pp., 4 folded plates, 7 x 5 in., flexible cloth. $1.50. (Gift from Author).

This handbook is intended to help the men now obtaining employment in shipyards to understand the unfamiliar terminology and processes of steel ship building. It gives, in a compact volume of pocket size, an alphabetical list of definitions of some 1 600 names, and plates illustrating about 300 parts of steel ships. The definitions have been collected from standard textbooks and a study of the methods now used in American shipyards.

THE BLUE BOOK OF FACTS OF MARINE ENGINEERING:

Including New Questions and Problems, with Answers That are Required for All Grades of Marine and Gas Engine License. 3d edition, revised, 1918. N. Y., Ocean Publishing Co. (copyright 1917). 116 pp., 6 x 4 in., cloth. $2.50.

This quiz compend gives the necessary information for obtaining marine engineers' licenses, in the form of questions and answers. These are classified according to the different grades of licenses.

MECHANISMS AND MECHANICAL MOVEMENTS:

A Treatise on Different Types of Mechanisms and Various Methods of Transmitting, Controlling, and Modifying Motion, to Secure Changes of Velocity, Direction, and Duration or Time of Action. By Franklin D. Jones. N. Y., The Industrial Press; Lond., The Machinery Pub. Co., Ltd., 1918. 310 pp., 164 illus., 9 x 6 in., cloth. $2.50.

The author has classified a variety of mechanical devices representing different types of mechanisms and illustrating important fundamental principles. He has also attempted, not only to explain how various mechanical motions may be produced and controlled, but also to show the relation between the theoretical and practical sides of the subject.

THE MOTOR TRUCK AS AN AID TO BUSINESS PROFITS.

By S. V. Norton. Chic., N. Y., and Lond., A. W. Shaw Co. (copyright 1918). 21 + 509 pp., 335 illus., 5 folded charts, 10 x 7 in., cloth. $7.50.

A collection of plans for using motor trucks in various businesses, showing what has been accomplished in actual practice. The adaptation of the motor truck to a business, its effective and economical utilization, its maintenance, and its part in developing the business are discussed in detail.

GAGES, GAGING, AND INSPECTION:

A Comprehensive Treatise Covering the Limit System, Measuring Machines, and Measuring Tools and Gages for Originating and Comparing Measurements in the Manufacturing and Inspection Departments, Including Means for Measuring and Inspecting Screw Threads and Gears. By Douglas T. Hamilton. N. Y., The Industrial Press; Lond., The Machinery Publishing Co., Ltd., 1918. 295 pp., 175 illus., 9 x 6 in., cloth. $2.50.

This is the first book, the author states, which deals exclusively with the subject, describes the principles and practical application of the limit system of interchangeable manufacturing, and the principal tools and gauges in use, comprehensively enough to meet the requirements of to-day.

FUEL ECONOMY IN BOILER ROOMS:

A Development of Fuel Economy and CO_2 Recorders Published in the Engineers' Study Course from *Power*. Part I: Fuel Economy and CO_2 Recorders, by A. R. Maujer and Charles H. Bromley; Part II: Fuel Economy in Boiler Rooms, by Charles H. Bromley. 2d ed. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Pub. Co., Ltd., 1918. 13 + 308 pp., 92 illus., 18 tab., 8 x 6 in., cloth. $2.50.

This volume contains a revised edition of the book previously published as "Fuel Economy and CO_2 Recorders", with the addition of matter on other subjects of interest in connection with efficiency in power plant operation. The authors have tried to provide a work for the use of firemen and power plant operating engineers, that will explain in simple language the proper means of attaining fuel economy.

AIRPLANE CHARACTERISTICS:

A Systematic Introduction for Flyer and Student and for All Who are Interested in Aviation. By Frederick Bedell. Ithaca, N. Y., Taylor and Co., 1918. 123 pp., 65 illus., 9 x 6 in., cloth. $1.75. (Gift from the Author.)

The art of flying, the author states, has progressed so far that the principles can in the main be set forth definitely and a collection of the essential elements be made that will apply to all airplanes, irrespective of type or structure. He has tried, therefore, to present a codification of the well-known ground work, which will give a direct, simple statement of the principles of airplane sustentation and stability and the characteristics of an airplane in flight. This work only partly covers the subject, but has been issued in its present form to meet the need of the moment.

SHEET METAL WORKERS' MANUAL:

A Complete, Practical Instruction Book on the Sheet Metal Industry, Machinery and Tools, and Related Subjects, Including the Oxy-Acetylene Welding and Cutting Process. By L. Broemel. With a Special Course in Elementary and Advanced Sheet Metal Work and Pattern Drafting for Technical and Trade School Instructors and Students; Also for Reference and Study by Sheet Metal Workers and Apprentices, by J. S. Daugherty. Chic., Frederick J. Drake & Co. (copyright 1918). 552 pp., 394 illus., 32 tab., 7 x 5 in., flexible cloth. $2.00. (Gift from the Peck, Stow and Wilcox Co.)

The authors have tried to produce a comprehensive textbook on the machinery, tools, and methods used in sheet metal working, suited to the needs of manual training and trade schools. Outline courses in sheet metal work and hand forging and welding which meet the requirements of emergency war training are included.

METALLURGY OF LEAD.

By H. O. Hofman. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Pub. Co., Ltd., 1918. 664 pp., 705 illus., 1 folded pl., 153 tab., 9 x 6 in., cloth. $6.00.

This work replaced the author's former treatise on "The Metallurgy of Lead and the Desilverization of Base Bullion", but has been so largely rewritten and altered that it has become practically a new book. Only the chapters on reverberatory smelting and German cupellation have been retained in about their original forms. The author has prepared for the new edition by a careful review of the technical literature on the subject and by visiting the leading lead plants of the United States and Canada, and has attempted to represent modern practice thoroughly and accurately.

THE FLOTATION PROCESS.

By Herbert A. Megraw. 2d ed., revised and enlarged. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1918. 11 + 359 pp., 74 illus., 1 pl., tab., 9 x 6 in., cloth. $3.50.

Although litigation over patent rights still continues, and there is still no agreement on the theory of the flotation process, the author has thought it advisable to issue a second edition of this work. In it the development of the process, both in theory and practice, is summarized, and an endeavor has been made to present as true a record of present conditions as is possible. Most of the original edition is retained, although some portions that later developments have made valueless are omitted, and considerable new matter has been added.

THE ZINC INDUSTRY.

By Ernest A. Smith. Lond. and N. Y., Longmans, Green and Co., 1918. 223 pp., illus., 2 diag., 4 pl., 1 map, tab., 9 x 6 in., cloth. $3.50.

The author of this volume, of the series of Monographs on Industrial Chemistry, has written a general survey of the development of the zinc industry and its present and possible future position in relation to the various metal industries of Great Britain. The rise and progress of the industry, the new materials and their sources, marketing of ores and metal, smelting, physical and chemical properties, industrial applications, and alloys are considered, and a bibliography of the more important publications is appended.

BOMBS AND HAND GRENADES, BRITISH, FRENCH, AND GERMAN:

A Handbook Showing Their Construction and Technicalities, Giving Full Instructions as to How to Use and How to Render Useless. By Captain Bertram Smith. N. Y., E. P. Dutton & Co. (copyright 1918). 90 pp., illus., 8 x 5 in., cloth. $2.00.

Descriptions of the types of bombs and hand grenades used by the different armies are given, with instructions for their use. Clear outline drawings of each type are included.

MINE TRACKS:

Their Location and Construction. Treating Briefly on the Materials Used and the Principles Involved in the Design and Installation, with a Set of Rules for a Standard Practice. By J. McCrystle. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1918. 10 + 105 pp., 23 illus., tab., 7 x 5 in., flexible cloth. $1.50.

The adaption of mechanical haulage and the successive increases in the weight of mine locomotives and rolling stock are making closer attention to mine tracks imperative, the author says. He has prepared this treatise to furnish a summary of the methods of several companies, by which systematic attention has been given to the subject, in convenient form for use by those responsible for the planning and maintenance of track work.

SHOP MANAGEMENT AND SYSTEMS:

A Treatise on the Organization of Machine Building Plants and the Systematic Methods that are Essential to Efficient Administration. By Franklin D. Jones and Edward K. Hammond. N. Y., The Industrial Press; Lond., The Machinery Publishing Co., Ltd., 1918. 307 pp., 159 illus., 9 x 6 in., cloth. $2.50.

The purpose of this volume is to give definite information on various systems that have been adopted, particularly in machine-building plants, to insure orderly and effective methods of procedure in the administration of manufacturing, designing, and purchasing departments. Concrete, rather than theoretical examples, fill the greater part of the book, and show the exact details of different systems and their application under various conditions.

LIFE IN A LARGE MANUFACTURING PLANT:

By Charles M. Ripley. Schenectady, N. Y., General Electric Co. (Gift from Author.)

A series of pamphlets describing the systematic plans which have been developed for selecting an efficient working force for the General Electric Company and for maintaining a high physical, mental, and moral standard.

THE ARBITRAL DETERMINATION OF RAILWAY WAGES.

By J. Noble Stockett, Jr. Bost. and N. Y., Houghton Mifflin Co., 1918. 198 pp., 8 x 5 in., cloth. $1.50.

This volume of the Hart, Schaffner, and Marx Prize Essays is a study of the principles of wage determination and of wage increase advanced by employes and employers in the course of arbitration proceedings, with a view to ascertaining some fundamental principles which may serve as the basis of a fair and reasonable wage or of a just principle of wage increase. The arbitration proceedings examined number sixty-five and include those settled under the provisions of the Erdman Act and the Newlands Act, the railway cases under the Industrial Disputes Investigation Act, the Eastern Engineers' Arbitration of 1912, and the Western Engineers and Firemen's Arbitration of 1915. The Contents are: Standardization; The Living Wage; The Increased Cost of Living; Increased Productive Efficiency; Principles Governing the Arbitral Determination of Wages.

METHODS OF MEASURING TEMPERATURE:

By Ezer Griffiths. With an Introduction by E. H. Griffiths. Lond., Chas Griffin and Co., Ltd.; Phila., J. B. Lippincott Co., 1918. 176 pp., 81 illus., 48 tab., 9 x 6 in., cloth. 8s. 6d. (Gift from J. B. Lippincott Co.)

This monograph, intended for those concerned with the measurement of temperature in scientific investigations or in the control of industrial operations, is chiefly devoted to the experimental basis of the methods in use, the calibration of the instruments, and the precautions necessary in practice. The volume is intended to extend the general treatment given in standard textbooks and to be complete in itself. References to the important literature are given with each chapter.

INTERPOLATION TABLES OR MULTIPLICATION TABLES

Of Decimal Fractions: Giving the Products to the Nearest Unit of All Numbers from 1 to 100 by 0.01 to 0.99, and from 1 to 1 000 by 0.001 to 0.999. By Henry B. Hedrick. Wash., Carnegie Institution, 1918. 139 pp., 14 x 10 in., cloth. $5.00.

These tables are of especial use in all problems involving the multiplication of decimal fractions of two or three digits where the product is required to no more significant figures than are contained in the smaller factor. Their use may be extended to decimal fractions of three and four digits. As the tables are more accurate than the slide-rule or graphical methods, and more convenient than logarithms, they are of value for many computations where those methods are ordinarily used.

DESCRIPTIVE GEOMETRY:

By William L. Ames and Carl Wischmeyer. 5th ed. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., 1918. 112 pp., 197 illus., 8 x 5 in., cloth. $1.00.

A condensed course for students in colleges of engineering, in which seventy-two problems are explained and illustrated, and four hundred exercises for solution are presented. The book accords with drafting-office practice by using the third quadrant.

GEORGE WESTINGHOUSE:

His Life and Achievements. By Francis E. Leupp. Bost., Little, Brown and Co., 1918. 10 + 304 pp., 5 pl., 6 por., 9 x 6 in., cloth. $3.00.

In this account of George Westinghouse, the inventor and the man, the author has gathered his material from such contemporary sources as old newspapers and magazines, corporate reports, Court records, local traditions, and the personal recollections of the friends and neighbors of Mr. Westinghouse. The trials and failures of his early life, his perseverance in the struggle for the recognition of his air-brake, and his later successes are pictured in detail. The numerous personal anecdotes which are scattered through the book add greatly to the interest of the biography as a human document.

AMERICAN ASSOCIATION OF ENGINEERS DIRECTORY:

Containing Lists of Members Arranged Alphabetically, Geographically, and According to Professional Work; Corrected to July 1st, 1918. Chic., American Association of Engineers (copyrighted 1918). 190 pp., 2 diag., 1 map, 9 x 6 in., cloth. $2.00.

The directory contains an account of the history, aims, and organization of the Society.

THE AMERICAN HOSPITAL OF THE TWENTIETH CENTURY:

A Treatise on the Development of Medical Institutions, Both in Europe and in America, Since the Beginning of the Present Century. By Edward F. Stevens. N. Y., Architectural Record Publishing Co., 1918. 274 pp., 454 illus., 10 x 7 in., cloth. $5.00.

Mr. Stevens presents plans of and information concerning a number of typical modern institutions, which show various solutions of the problems of housing and treating the sick. He adds also to his illustrations a summary of the results of his own experience in hospital construction and his study of European institutions.

MODERN HOT WATER HEATING, STEAM AND GAS FITTING:

By William Donaldson. Chic., Frederick J. Drake & Co. (copyright 1918). 256 pp., 11 illus., 39 tab., 8 x 5 in., cloth. $1.50.

An elementary description of apparatus and methods of installing it.

PLANE SURVEYING:

A Practical Treatise on the Art of Plane Surveying, Including Chaining, Leveling, Compass and Transit Measurements, Land and Construction Surveying, Topographic Surveying, and Mapping. By J. K. Finch. Chic., American Technical Society, 1918. 243 pp., 154 illus., 11 pl., 10 tab., 7 x 5 in., flexible cloth. $1.50.

This manual is especially intended for home study. It is planned to give the practical man a working knowledge of the subject, and to be used by trained surveyors as a convenient review.

WATER-WORKS HANDBOOK:

Compiled by Alfred Douglas Flinn, Robert Spurr Weston, and Clinton Lathrop Bogert. 2d ed. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1918. 824 pp., 411 illus., 313 tab., 9 x 6 in., flexible cloth. $6.00. (Gift from Authors.)

The new edition of this compilation of information for designers and operators of water-works differs only in minor matters from the first one, published in 1916. All errors which have been found have been corrected, some small additions of new material have been made, and a few portions have been rewritten to utilize recent information.

SUMMARY OF SOCIETY MEMBERSHIP SERVING IN THE ARMIES AND NAVIES OF THE UNITED STATES AND ITS ALLIES

November 14th, 1918

AMERICAN ARMY

Major-Generals	9
Brig.-Generals	15
Colonels	49
Lt.-Colonels	50
Majors	233
Captains	535
First Lieutenants	276
Second Lieutenants	83
Regimental Sergeants	1
Master Engineers	7
Master Gunners	2
Sergeants	13
Corporals	8
Privates	46
Students, Training Camps	17
Miscellaneous	5
Total	1349

BRITISH ARMY

Brig.-Generals	1
Lt.-Colonels	5
Majors	10
Captains	16
Lieutenants	16
Second Lieutenants	6
Corporals	2
Privates	1
Miscellaneous	1
Total	58

FRENCH ARMY

Commandant (rank not given)	1
Captains	2
Sous-Lieutenant	1
Aspirant	1
Miscellaneous	2
Total	7

ITALIAN ARMY

Colonel	1
Total in Armies	1415

SUMMARY FOR ARMIES

Major-Generals	9
Brig.-Generals	16
Colonels	50
Lt.-Colonels	55
Majors	243
Commandant (rank not given)	1
Captains	553
Lieutenants	292
Second Lieutenants	90
Regimental Sergeants	1
Master Engineers	7
Master Gunners	2
Sergeants	13
Corporals	10
Privates	47
Students, Training Camps	18
Miscellaneous	8
Total	1415

AMERICAN NAVY

Rear-Admirals	5
Captains	5
Commanders	10
Lt.-Commanders	16
Civil Engineers (rank not given)	13
Lieutenants	24
Lieutenants (Junior Grade)	11
Ensigns	11
Asst. Paymaster (rank not given)	1
Chf. Machinist's Mate	2
Chf. Carpenter's Mate	1
Marine	1
Miscellaneous	1
Total	101

BRITISH NAVY

Lieutenant	1
Total in Navies	102

SUMMARY FOR NAVIES

Rear-Admirals	5
Captains	5
Commanders	10
Lt.-Commanders	16
Civil Engineers (rank not given)	13
Lieutenants	25
Lieutenants (Junior Grade)	11
Ensigns	11
Asst. Paymaster (rank not given)	1
Chf. Machinist's Mate	2
Chf. Carpenter's Mate	1
Marine	1
Miscellaneous	1
Total	102

RECAPITULATION

Total in Army	1415
Total in Navy	102
Total on Roll of Honor	1517
Died in Service	11
Grand Total	1528

ROLL OF HONOR

A List of Members of the Society Who are Serving in the Army or Navy of the United States or Any of Its Allies.*

VANSITTART, GEORGE EDWARD. *Maj., 13th Battery, Canadian Field Artillery, 2d Canadian Div.; wounded in action (France); died May 14th, 1916.*

AGNEW, AUGUSTUS WATEROUS. *Capt., 3d Canadian Pioneers; wounded in action (France); died September 17th, 1916.*

HAGUE, WILLIAM. *1st Lieut., Engr. R. C., 116th Engrs.; died in service (France), January 1st, 1918.*

GOODFELLOW, JAMES GORDON. *Maj., Royal Engrs.; killed in action (France), March 23d, 1918.*

BUCKWALTER, HARRIS DANIEL. *Capt., Engr. R. C.; killed in action (France), May 12th, 1918.*

LINDBERY, CHARLES ARTHUR. *Capt., Engr. R. C.; died in service (Camp Lee, Va.), May 27th, 1918.*

ANNEAR, EDGAR HAROLD. *Capt., Engr. R. C.; died in service (Hoboken, N. J.), August 28th, 1918.*

SLEPPY, KIRBY BALDWIN. *Capt., Engineers, U. S. A., 4th Engrs.; killed in action (France).*

ALEXANDER, EDWARD PORTER. *1st Lieut., Engineers, U. S. A., 509th Engrs.; died in service (France), September 5th, 1918.*

McCLURE, HUNTER. *1st Lieut., Engineers, U. S. A., Co. N, 21st Engrs.; died in service (France), September 26th, 1918.*

REAM, WARD HALL. *1st Lieut., Engineers, U. S. A., Co. C, 305th Engrs.; killed in action (France), October 4th, 1918.*

Abbot, Frederic V. Brig.-Gen., Engineers, U. S. A.

Abbot, Frederick William. Lt.-Col., British Army.

Acher, A. H. Maj., Engineers, U. S. A.; Acting Lt.-Col., 4th Engrs., A. E. F., France.

Acker, Robert L. Corporal, Headquarters Co., 7th F. A., A. E. F., France.

Ackerman, Alexander S. Capt., Engineers, U. S. A., A. E. F., France.

Ackerman, Arthur P. 1st Lieut., Engineers, U. S. A., 517th Engrs.

Adams, Arthur. Maj., Ordnance, U. S. A.

Adams, Edward M. Maj., U. S. A.

Adams, Milton Jewell. Capt., Engineers, U. S. A., Co. C, 114th Engrs.

Adams, Raymond E. Capt., Quartermaster Corps, U. S. A.

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* This list is made up from replies to a circular forwarded to members of the Society, and others, and is probably neither accurate nor complete. It is requested that the attention of the Secretary be called to any omissions or inaccuracies in order that they may be corrected in subsequent lists.

Adams, Walter Francis. Sergeant, Co. E, 2d Bn., 23d Engrs., A. E. F., France.

Adams, William H. Capt., Quartermaster Corps, U. S. A.

Albert, Frederick W. Lt.-Col., Engineers, U. S. A., 33d Engrs.

Alden, Herbert C. 1st Lieut., Coast Artillery, U. S. A.

Alden, Langford Taylor. Aspirant, 7e Batterie, 51st Regt. d'Artillerie, Secteur Postal No. 82 (French Army); Care, Morgan, Harjes Cie., Boulevard Haussmann, Paris, France.

Alderman, Ernest S. 2d Lieut., Quartermaster Corps, U. S. A.

Alexander, Kay. Maj., 2d in Command, 12th Canadian Ry. Troops, B. E. F., France.

Allen, Franklin R. Capt., Engineers, U. S. A.

Allen, Herschel Heathcote. Capt., Engineers, U. S. A.

Allen, Ralph B. 1st Lieut., Engineers, U S. A., Co. B, 25th Engrs., A. E. F., France.

Allen, Walter Henry. Maj., Engineers, U. S. A.

Allen, Walter Hinds. Lt.-Commander, Civil Engineer Corps, U. S. N.

Allison, L. M. 2d Lieut., Infantry, U. S. A., Co. E, 2d Inf. Replacement Regt.

Allison, William F. Maj., Engineers, U. S. A., A. E. F., France.

Altman, Frank S. Lieut., Engineers, U. S. A., 23d Engrs.

Altstaetter, F. W. Col., Engineers, U. S. A.

Anders, Frank L. Capt., Quartermaster Corps, U. S. A.

Anderson, J. E. Maj., 212th Field Co., Royal Engrs., B. E. F., France.

Anderson, J. H. Capt., Engineers, U. S. A.; Adjt., 1st Replacement Engrs.

Anderson, W. P. Capt., Engineers, U. S. A., A. E. F., France.

Anderson, W. S. Cadet, School of Military Aeronautics, U. S. A.

Andrew, Clarence R. Capt., Engineers, U. S. A., 32d Engrs.

Andrews, Carl B. Capt., Engineers, U. S. A.

Andrews, J. H. M. Lt.-Col., Ordnance, U. S. A.

Angas, Robert M. 1st Lieut., U. S. A., 106th Engrs.

Applegarth, Gault. Capt., Engineers, U. S. A., 23d Engrs.

Ardery, Edward Dahl. Col., Engineers, U. S. A.

Armitage, George W. Capt., Quartermaster Corps, U. S. A.

Arms, Leo M. Lieut., Engineers, U. S. A., Co. F, 2d Engrs., A. E. F., France.

Armstrong, Charles Johnstone. Brig.-Gen.; Chf. Engr., H. Q., Canadian Army Corps, B. E. F., France.

Armstrong, Harry A. 6th Co., E. O. T. C., Camp A. A. Humphreys, Va.

Armstrong, Merwin. Capt., Engineers, U. S. A., Co. D, 105th Engrs., A. E. F., France.

Arn, William G. Maj., Engineers, U. S. A., 13th Engrs. (Ry.), Postal Sector 215, A. E. F., France.

Arnold, Bion J. Lt.-Col., Air Service, U. S. A.

Ashkins, Nathan Thomas. 1st Lieut., Engineers, U. S. A., Lines of Communication, Eng. Headquarters, A. E. F., France.

Ashley, Carl. Capt., Engineers, U. S. A., U. S. M. P. O. 702, A. E. F., France.

Ashmead, P. H. Maj., Engineers, U. S. A.

Ashton, Raymond. 2d Lieut., Air Service, U. S. A., A. E. F., France.

Asplundh, E. T. Capt., Engineers, U. S. A.; Supply Officer, 103d Engrs.

Asserson, Henry Raymond. Maj., Engineers, U. S. A., C. E. L. O. C., A. E. F., France.

Atterbury, W. W. Brig.-Gen.; Director-General of Transportation, A. E. F., France.

Atwood, William G. Lt.-Col., Engineers, U. S. A., 17th Engrs. (Ry.), U. S. A. P. O. 701, A. E. F., St. Nazaire, France.

Austill, Hurieosco. Capt., Engineers, U. S. A., Co. D, 501st Engrs. (Service Bn.), A. E. F., France.

Austin, H. A. R. 1st Lieut., Engineers, U. S. A.

Ayres, John Henry. Capt., Engineers, U. S. A., Co. D, 42d Engrs.

Ayres, Quincy C. 2d Lieut., Engineers, U. S. A. (*Unattached*), A. E. F., France.

Babbitt, Harold E. Capt., Engineers, U. S. A., U. S. P. O. No. 757, A. E. F., France.

Baffrey, Charles R. Capt., 102d Reg. d'Artillerie (French Army), Secteur Postal 160, B. C. M., Paris, France.

Bailey, Lewis P. Capt., Engineers, U. S. A., Co. A, 304th Engrs.

Bakenhus, R. E. Commander, Civil Engineer Corps, U. S. N.

Baker, George L. 1st Lieut., Infantry, U. S. A.

Baker, H. S. Lt.-Col., Engineers, U. S. A., 111th Engrs.

Baker, Shirley. Capt., Engineers, U. S. A., Co. B, 23d Engrs.

Balch, William H. Capt., Engineers, U. S. A., A. P. O. 712, A. E. F., France.

Barber, Charles W. Private, 38th Engrs.

Barber, Justin F. Sergeant, Co. M, 23d Engrs., A. E. F., France.

Barber, Norman N. Capt., Engineers, U. S. A., 16th Engrs., A. E. F., France.

Barclay, A. J. 1st Lieut., Engineers, U. S. A.

Barnard, Archer F. 1st Lieut., Engineers, U. S. A.

Barney, Samuel E. Maj., Engineers, U. S. A. (*Unassigned*).

Barry, E. J. Maj., Engineers, U. S. A.

Bartholomew, B. W. Lieut., Engineers, U. S. A., 301st Engrs.

Bascom, George R. Maj., Sanitary Corps, U. S. A.

Bass, Fred T. Capt., Engineers, U. S. A., Headquarters, 1st Bn., 32d Engrs., A. E. F., France.

Bassett, Herbert H. Maj., Engineers, U. S. A.

Battie, H. S. 1st Lieut., Engineers, U. S. A.

Baxter, O. G. Capt., Engineers, U. S. A., Co. C, 601st Engrs.

Bayliss, Paul. 2d Lieut., Engineers, U. S. A., 8th Engrs. (Mounted).

Beach, Lansing H. Col., Engineers, U. S. A.

Beale, Allan S. Lieut., U. S. Air Service (Aeronautics).

Beall, Pendleton. Private, Headquarters Co., 165th Inf., A. E. F., France.

Beam, Carl Eugene. 2d Lieut., Engineers, U. S. A.

Bean, Paul Jones. Civ. Engr., U. S. N.

Bebb, Edward C. Capt., Engineers, U. S. A.

Bee, Charles E. 1st Lieut., Engineers, U. S. A.

Beeman, Thomas R. Capt., Engineers, U. S. A., Care, D. G. T., A. E. F., France.

Beerbower, Dumont. Capt., Engineers, U. S. A., Co. C, 535th Engrs.

Begg, R. B. H. Capt., Engineers, U. S. A., A. E. F., France.

Behrman, I. E. 1st Lieut., Engineers, U. S. A., Care, C. E. O., Zone of the Advance, A. E. F., France.

Bell, George Edward. Lieut., Canadian Engrs., Care, Bank of Montreal, Waterloo Pl., London, S. W. 1, England.

Bell, Harry W. Capt., Engineers, U. S. A., 5th Bn., 22d Engrs., A. E. F., France.

Bellinger, L. F. Commander, Civil Engineer Corps, U. S. N.

Benham, Claude Gilbert. Capt., Coast Artillery, U. S. A.

Benham, W. L. Maj., Quartermaster Corps, U. S. A.

Bennett, John W. F. Maj., Quartermaster Corps, U. S. A., Consti Div.

Bennison, Ernest William. 1st Lieut., Engineers, U. S. A., 23d Engrs.

Bensel, J. A. Maj., Engineers, U. S. A.

Benson, Orville. Maj., Engineers, U. S. A., A. E. F., France.

Berdeau, Ray W. Capt., Engineers, U. S. A.; Engr. Officer, 220th Engrs.

Bergan, Thomas B. Lieut., U. S. A.

Betts, Clifford A. 1st Lieut., Coast Artillery, U. S. A., Battery E, 52d Artillery, A. E. F., France.

Bickel, George R. Chf. Machinist's Mate, U. S. N. R. F.

Biddle, John. Maj.-Gen., U. S. A.

Billings, A. W. K. Lt.-Commander, Civil Engineer Corps, U. S. N. R. F., U. S. Naval Forces (Aviation), London, England.

Billings, Fred M. Capt., Engineers, U. S. A.

Binckley, George Sydney. Maj., Engineers, U. S. A., 112th Engrs.

Binger, Walter D. 2d Lieut., Signal Corps, U. S. A.

Birdseye, Claude H. Maj., Engineers, U. S. A., Office, Chf. of Artillery, A. P. O. 706, A. E. F., France.

Bishop, Roy P. 2d Lieut., Engineers, U. S. A., 35th Engrs., A. P. O. 735, A. E. F., France.

Bither, T. A. 2d Lieut., Signal Corps, Aviation Section, U. S. A.

Bixby, William H. Brig.-Gen., U. S. A. (*Retired*).

Black, Dudley F. Capt., Engineers, U. S. A., Co. C, 513th Engrs., A. E. F., France.

Black, E. B. Maj., A. S. (P.), U. S. A.

Black, G. G. Capt., Engineers, U. S. A.; Acting Adjt., 314th Engrs.

Black, James B. 1st Lieut., Engineers, U. S. A., Chf. Engr.'s Office, Headquarters, A. E. F., France.

Black, Ralph P. 1st Lieut., Engineers, U. S. A., 32d Engrs.

Black, Roger Derby. Lt.-Col., Engineers, U. S. A., Headquarters, A. E. F., France.

Black, Walter G. 1st Lieut., Co. 7, E. O. T. S., Camp A. A. Humphreys, Va.

Black, William M. Maj.-Gen., U. S. A.; Chf. of Engrs., U. S. A.

Blackman, J. W. B. Lieut., Canadian Ry. Troops, C. E. F., France.

Blair, Alexander. 2d Lieut., Royal Engrs., B. E. F., France.

Blair, McCrea Parker. Capt., No. 1 Depot Bn., Manitoba Regt., Winnipeg, Man., Canada.

Blanchard, Murray. Maj., Engineers, U. S. A., 520th Engrs.

Boesch, Clarence E. Capt., U. S. A., Co. B, 105th Engrs.

Boggs, F. C. Col., U. S. A., 315th Engrs.

Boland, Charles J. 1st Lieut., Signal Corps, U. S. A., 80th Aero Squadron, A. E. F., France.

Bolin, Harry W. Sergeant, Co. E, 23d Engrs.

Bolton, Frank L. Capt., Engineers, U. S. A.

Bond, P. S. Col., U. S. A., 107th Engrs.; Div. Engr., 32d Div., Army Engr. School, U. S. P. O. 714, A. E. F., France.

Bonner, John P. Capt., Coast Artillery, U. S. A., A. E. F., France.

Boorman, Kitchell M. Lieut., U. S. A., Office, Chf. Engr., 2d Army, A. P. O. 784, A. E. F., France.

Booth, Raymond. 1st Lieut., Engineers, U. S. A., 54th Engrs.

Booz, Horace Corey. Col., Railroad Transportation Corps, U. S. A., Care, D. G. T., A. E. F., France.

Borchers, Perry E. Capt., Engineers, U. S. A.

Borden, Guy. Co. 2, E. O. T. C., Camp Humphreys, Va.

Boschke, Guy. Maj., Engineers, U. S. A., M. P. O. 705, A. E. F., France.

Bott, C. N. 1st Lieut., Engineers, U. S. A., 312th Engrs.

Boult, Charles N. 2d Lieut., 28th Reinforcements, New Zealand Engrs., N. Z. E. F., Care, P. O., Wellington, New Zealand.

Bowen, Charles K. Capt., Engineers, U. S. A.

Bowen, Edward Withers. Capt., Infantry, U. S. A., 2d Inf. Replacement Regt.

Bowie, William. Maj., Engineers, U. S. A.

Bowlby, Henry L. Maj., U. S. A., 43d Engrs.

Bowles, James T.-B. Maj., Sanitary Corps, U. S. A.

Bowne, Sidney B. 2d Lieut., U. S. Public Health Service.

Boyd, George R. Capt., Engineers, U. S. A., A. E. F., France.

Boyden, Harry C. Maj., Engineers, U. S. A.

Boyle, James M. Maj., Ordnance, U. S. A.

Brace, James H. Maj., U. S. A., 22d Engrs., A. E. F., France.

Bragg, Kendal B. Lieut., U. S. N.

Braly, Raymond F. 1st Lieut., Engineers, U. S. A.

Braunworth, Percy L. Capt., Engineers, U. S. A., Care, Director-General of Transportation, Army P. O. 705, A. E. F., France.

Bres, Edward Sedley. 1st Lieut., Engineers, U. S. A., 114th Engrs.

Breuchaud, Jules R. Capt., Quartermaster Corps, U. S. A., Constr. Div.

Brewster, Henry B. Capt., Engineers, U. S. A., and Adjt., 303d Engrs.

Breymann, John B., Jr. 2d Lieut., Coast Artillery, U. S. A., 22d Co.

Briggs, Robert W. 2d Lieut., Signal Corps, Aviation Section, U. S. A., 73d Aero Constr. Squadron.

Bright, Graham B. Capt., Engineers, U. S. A., and Regimental Adjt., 305th Engrs. (Pioneers).

Brinkley, Milo H. Capt., Engineers, U. S. A.

Bronson, Howard F. Capt., Sanitary Corps, U. S. A.

Brook, A. E. Capt., Royal Engrs., B. E. F., France.

Brooking, J. H. Capt., Engineers, U. S. A., Co. B, 12th Engrs. (Ry.), A. E. F., France.

Brooks, Josiah R. 1st Lieut., Engineers, U. S. A.

Brown, Charles E. Capt., Engineers, U. S. A.

Brown, Clarence C. 1st Lieut., Co. E, 12th Engrs. (Ry.), A. E. F., France.

Brown, Earl I. Col., U. S. A., 317th Engrs.

Brown, Elbert C. Capt., Engineers, U. S. A., 142d Engrs.

Brown, Elliot C. Lt.-Commander, U. S. N. R.

Brown, H. Whittemore. 2d Lieut., Engineers, U. S. A., A. E. F., France.

Brown, Harry Madara. 1st Lieut., Infantry, U. S. A. (*Unassigned*).

Brown, Levant R. Capt., Engineers, U. S. A.

Brown, Marshall W. Maj., Engineers, U. S. A., P. O. 702, A. E. F., France.

Brown, Norman F. Maj., Railroad Transportation Corps, U. S. A., Care, Director-Gen. of Transportation, A. E. F., France.

Brown, Robert H. Maj., Sanitary Corps, U. S. A.

Brownell, E. H. Commander, Civil Engineer Corps, U. S. N.

Bruner, Louis S. 1st Lieut., Engineers, U. S. A., 23d Engrs., A. E. F., France.

Brush, Carl F. Capt., Engineers, U. S. A., A. P. O. 716, A. E. F., France.

Bruton, Philip G. 2d Lieut., Constr. Div., Aviation Section, Signal Corps, U. S. A.

Bryan, Clark A. Capt., Engineers, U. S. A.

Bryan, George, Jr. 1st Lieut., Engineers, U. S. A.

Buchanan, Warren Henderson. Chf. Machinist Mate, U. S. N. R. F.

Bucher, Harold F. Lieut., Engineers, U. S. A., 2d Engrs., A. E. F., France.

Buck, Richard S. Maj., 11th Engrs. (Ry.), A. E. F., France.

Buck, Walter Van. Capt., Engineers, U. S. A., 23d Engrs.

Bull, George M. Civ. Engr., U. S. N. R. F.

Bunker, George H. Capt., Engineers, U. S. A., 306th Engrs.

Bunker, Stephen S. Capt., Engineers, U. S. A., Co. C, 503d Service Bn., A. E. F., France.

Burd, Edward M. Capt., Coast Artillery, U. S. A.

Burdett, O. L. Capt., Engineers, U. S. A., Co. A, 25th Engrs., A. E. F., France.

Burger, Alfred A. 2d Lieut., Infantry, U. S. A., 19th Co., 2d Inf. Replacement Regt.

Burgess, Harry. Col., U. S. A., 16th Engrs. (Ry.), A. E. F., France.

Burkett, Joseph M. Capt., Engineers, U. S. A., A. E. F., France.

Burky, C. R. Capt., Signal Corps, Aviation Section, U. S. A.

Burr, Edward. Col., Engineers, U. S. A., Manila, Philippine Islands.

Burrell, Glenn S. Lt.-Commander, Civil Engineer Corps, U. S. N.

Burrowes, H. G. 1st Lieut., Engineers, U. S. A., Co. B, 25th Engrs., A. E. F., France.

Burt, Henry J. Maj., Quartermaster Corps, U. S. A.

Burton, William. 1st Lieut., Engineers, U. S. A.

Bush, Lee M. Central Officers' Training School, Camp Zachary Taylor, Ky.

Bush, Lincoln. Col., Quartermaster Corps, U. S. A.

Bushnell, Howard B. Capt., Engineers, U. S. A., A. E. F., France.

Bushnell, Howard E. Capt., Engineers, U. S. A.

Busse, Franz A. Capt., Engineers, U. S. A. (*Unattached*), A. E. F., France.

Butler, John Soule. Maj., Engineers, U. S. A.

Butler, Millard A. Col., Quartermaster Corps, U. S. A.

Butler, William P. Lieut., U. S. N. R. F

Byam, L. H. Capt., Engineers, U. S. A.

Byllesby, Henry M. Maj., Signal Corps, Aviation Section, U. S. A.

Byrd, J. H. Capt., Engineers, U. S. A., 314th Engrs.

Byrne, Thomas Sneed. Capt., Ordnance, U. S. A.

Caffall, Geoffrey A. Private, No. 1 Coy., Canadian Machine Gun Depot, Seaford, Sussex, England.

Caldwell, William H. Lieut., U. S. N. R. F.

Cameron, Harry Frank. Lt.-Col., U. S. A., 209th Engrs.

Camp, George Dashiell. 1st Lieut., Engineers, U. S. A., 316th Engrs.

Campbell, Charles C. Private, Co No. 13, Motor Group, Medical Corps, U. S. A.

Canfield, George Hathaway. Capt., Engineers, U. S. A., 316th Engrs.

Carey, Matthew L. Capt., Quartermaster Corps, U. S. A., A. E. F., France.

Carey, William N. Maj., U. S. A., 1st Bn., 313th Engrs.

Carlin, J. P. Capt., Engineers, U. S. A.

Carlson, Carl Alexius. Lt.-Commander, Civil Engineer Corps, U. S. N.

Caro, Phillip. Lieut., 2d Junior Co., No. 4 Command Depot, A. T. F., Codford, Wiltshire, England.

Carr, Dean O. Capt., U. S. A., 150th Engrs.

Carr, G. W., Jr. Co. F, 3d Provisional Regt., 156th Depot Brigade, U. S. A.

Carroll, James E. Maj., Engineers, U. S. A., 527th Engrs., A. P. O. 701, A. E. F., France.

Carter, E. Kemper. Capt., Engineers, U. S. A., Co. C, 518th Engrs.

Case, Charles A. 1st Lieut., Engineers, U. S. A., 314th Engrs.

Cate, Charles Edward. Capt., U. S. A., 45th Engrs., A. E. F., France.

Caton, John H., 3d. Capt., Engineers, U. S. A., Co. F, 33d Engrs.

Cattell, William A. Maj., Engineers, U. S. A.

Cerny, John W. Maj., Quartermaster Corps, U. S. A.

Chadwick, Maurice F. Private, 24th Tr. Bn., F. A. R. D., Camp Jackson, S. C.

Chamberlaine, Robert L. Capt., Aviation Section, Signal Corps, U. S. A.

Chambers, Frank T. Capt., Civil Engineer Corps, U. S. N.

Chandler, William E. Master Gunner, Headquarters Co., 55th Artillery, C. A. C., A. P. O. 723, A. E. F., France.

Chapman, Mellville D. Capt., U. S. Marine Corps, Machine Gun Bn., 5th Brigade, A. E. F., France.

Chapman, S. A. 1st Lieut., U. S. A., Headquarters, 2d Bn., 10th Engrs. (Forestry), A. E. F., France.

Chappell, Claude E. Capt., Co. 5, E. O. T. C., Camp Humphreys, Va.

Charnley, Walter. 1st Lieut., Engineers, U. S. A.

Chase, Clifford E. Capt., Engineers, U. S. A., Co. A, 4th Engrs.

Chase, Dean. 1st Lieut., Coast Artillery, U. S. A., Battery E, 62d Regt., C. A. C., A. E. F., France.

Cheney, Sherwood A. Col., U. S. A., 110th Engrs., A. E. F., France.

Cherry, Alan Gordon. 1st Lieut., U. S. A., 301st Engrs.

Chevalier, Willard T. Capt., Engineers, U. S. A., Co. D, 11th Engrs. (Ry.), A. E. F., France.

Child, John T. 2d Lieut., Sanitary Corps, U. S. A.

Childs, James A. Capt., Sanitary Corps, U. S. A.

Chipley, Dudley. Capt., Quartermaster Corps, U S. A., Constr. Div.

Chittenden, Albert Frederick. 1st Lieut., Engineers, U. S. A., Co. F, 18th Engrs. (Ry.), P. O. No. 705, A. E. F., France.

Christensen, George A. Maj., Quartermaster Corps, U. S. A.

Christie, C. de B. Capt., Engineers, U. S. A.

Christophers, Reginald Gillon. (No. 60286), 2d Lieut., 34th Reinforcements, N. Z. E. F., Care, G. P. O., Wellington, New Zealand.

Church, Elihu C. Capt., Engineers, U. S. A., A. E. F., France.

Churchill, Percival M. Maj., Engineers, U. S. A., Headquarters, 538th Engrs.

Churchill, Robert C. Lieut., U. S. A., Co. F, 12th Engrs. (Ry), A. E. F., France.

Claflin, William B. Capt., Engineers, U. S. A., Headquarters, 39th Div.

Claiborne, Herbert A., Jr. 2d Lieut., Signal Corps, U. S. A. (*Unassigned*).

Clark, Ernest A. Capt., Engineers, U. S. A.

Clark, Howard F. Capt., Engineers, U. S. A., A. E. F., France.

Clarke, Harry L. 1st Lieut., Engineers, U. S. A., Co. E, 28th Engrs.

Clarke, Thomas C. Lt.-Col., 110th Engrs., A. E. F., France.

Clarke, W. D. Capt., Engineers, U. S. A., 23d Engrs. (Highway), A. E. F., France.

Class, C. Frank. Capt., Engineers, U. S. A.

Clayton, Thomas W. Capt., Engineers, U. S. A., A. E. F., France.

Cleckner, Frederick M. Private, Meteorological Section, Signal Corps, U. S. A.

Cleveland, Lou B. 1st Lieut., Engineers, U. S. A., Co. D, 105th Engrs.

Clinton, Delmar S. Maj., Engineers, U. S. A.

Cobb, William R. Lieut., U. S. N. N. V., U. S. S. *Frederick*.

Cochrane, Victor Hugo. Maj., Quartermaster Corps, U. S. A.

Coe, C. S. Maj., Engineers, U. S. A., 17th Engrs. (Ry.), A. P. O. 701, A. E. F., France.

Coe, David. Capt., R. E., Care, R. C. E., Communications, A. P. O., S 1, B. E. F., France.

Coe, E. K. Maj., Engineers, U. S. A., Care, C. E. O., L. of C., U. S. M. P. O. No. 702, A. E. F, France.

Cole, Howard J. Capt., Engineers, U. S. A.

Coleman, Eugene H. Capt., Engineers, U. S. A., 312th Engrs.

Colgan, R. J. Capt., 11th Engrs. (Ry.), A. E. F., France.

Collier, W. N. Capt., Engineers, U. S. A.

Collins, Earl H. Capt., Coast Artillery, U. S. A.

Collins, Merton C. 1st Lieut., Engineers, U. S. A.

Columbia, Curtis F. 1st Lieut., Coast Artillery, U. S. A., Heavy Artillery Headquarters, A. E. F., France.

Comly, Harry S. Meteorologist, Signal Corps, 32d Service Co., Meteorological Section, U. S. A.

Comly, James R. 1st Lieut., Engineers, U. S. A., 55th Engrs.

Compton, Arthur M. Lt.-Col., U. S. A., 126th F. A.

Compton, R. Keith. Maj., Engineers, U. S. A.

Conard, Clarence Knight. Maj., Ordnance, U. S. A.

Conard, R. A. Civ. Engr., U. S. N. R. F., Port au Prince, Haiti.

Connelly, Walter L. Master Engr., Senior Grade, Headquarters Detachment, 310th Engrs.

Connolly, A. H. Cadet, School of Military Aeronautics, U. S. A.

Connor, W. D. Col., U. S. A., Gen. Staff; Asst. Chf. of Staff, A. E. F., France.

Converse, Joseph B. Lieut., U. S. A., Constr. Div.

Conway, N. B. Capt., Engineers, U. S. A., 516th Engrs.

Cook, Paul D. Maj., Engineers, U. S. A.

Cooke, Frederick H. Lt.-Commander, Civil Engineer Corps, U. S. N.

Cooksey, R. M. Maj., Quartermaster Corps, U. S. A.

Coombs, Robert D. Maj., Ordnance, U. S. A.

Coomer, R. M. Capt., Engineers, U. S. A., Headquarters, Eng. Corps, Line of Communications, A. E. F., France.

Cooper, David R. Capt., Engineers, U. S. A., A. E. F., France.

Cooper, Hugh L. Lt.-Col., U. S. A., A. E. F., France.

Copeland, Robert Morris. Capt., Engineers, U. S. A.

Corkran, Wilbur Sherman. Maj., Engineers, U. S. A.

Cornell, J. W. Capt., Quartermaster Corps, U. S. A.

Cornish, Lorenzo D. Capt., Engineers, U. S. A., Co. C, 15th Engrs. (Ry.), A. E. F., France.

Corp, Henry W. 5th Co., E. O. T. S., Camp Humphreys, Va.

Cosby, Spencer. Col., Engineers, U. S. A., 5th Engrs.

Cotter, Carl Henry. Lieut., Civil Engineer Corps, U. S. N.

Covert, John F. 1st Lieut., Engineers, U. S. A.

Cowles, William Pierce. Maj., Engineers, U. S. A., 34th Engrs., A. E. F., France.

Cox, Leonard M. Commander, Civil Engineer Corps, U. S. N.

Coy, Burgis G. Capt., Engineers, U. S. A., Co. D, 314th Engrs., A. E. F., France.

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Crandall, Carl. Flying Cadet, U. S. Air Service.

Crane, Albert Eli. 1st Lieut., Engineers, U. S. A., 6th Engrs., A. E. F., France.

Crane, Joseph S. Maj., Quartermaster Corps, U. S. A.

Crawford, Hugh W. Capt., U. S. A., Co. A, 110th Engrs.

Crawford, Ivan C. Maj., U. S. A., 115th Engrs., A. E. F., France.

Crecelius, S. F. Lt.-Col., Engineers, U. S. A., 101st Engrs., A. E. F., France.

Crocker, Herbert Samuel. Lt.-Col., Quartermaster Corps, U. S. A.

Crocker, James R. Capt., Engineers, U. S. A., Co. F, 106th Engrs.

Cronemeyer, J. F. W. Co. 3, E. O. T. S., Camp Humphreys, Va.

Crooks, Clinton H. Capt., Engineers, U. S. A.

Crosby, W. W. Lt.-Col., Engineers, U. S. A.

Crowell, Francis S. Capt., Quartermaster Corps, U. S. A.

Crozier, William. Maj.-Gen., U. S. A.; Chief of Ordnance, U. S. A.

Cudebec, Albert B. Capt., Engineers, U. S. A., U. S. Military P. O. No. 702, A. E. F., France.

Culver, Arthur. Lieut., R. E., 156th Field Co., R. E., B. E. F., France.

Cunliff, Charles, Jr. Lieut., U. S. A., 403d Engrs.

Cunningham, John G. L. Capt., Ordnance, U. S. A.

Curfman, Lawrence E. Lt.-Col., 314th Engrs., A. E. F., France.

Curley, J. F. Maj., Ordnance, U. S. A.

Currey, J. W. 1st Lieut., Engineers, U. S. A., Co. C, 115th Engrs.

Currie, Thomas A., Jr. Private, 116th Engr. Detachment, A. P. O. 727, St. Aignan-Noyers, A. E. F., France.

Cushing, Edward B. Maj., Engineers, U. S. A.; Supt., Army Transport Service, U. S. A. P. O. No. 705, A. E. F., France.

Cutler, Leon G. Capt., Coast Artillery, U. S. A., 57th Artillery, C. A. C., A. E. F., France.

Dallis, Park A. Capt., Engineers, U. S. A.; Adjt., 24th Engrs.

Daly, A. P. V. 2d Lieut., 4th Connaught Rangers; 48 Cathcart Rd., London, S. W., England.

Daly, D. A. Capt., Engineers, U. S. A., 16th Engrs., A. E. F., France.

Daly, John W. Lieut., Infantry, U. S. A.

Danforth, George Clapp. Capt., Engineers, U. S. A., 602d Engrs., A. E. F., France.

Darling, Clinton Stowell. Capt., U. S. A., 108th Engrs., A. P. O. 750, A. E. F., France.

Darville, M. A. 2d Lieut., Engineers, U. S. A., A. E. F., France.

Davidson, George B. 2d Lieut., Engineers, U. S. A.

Davies, J. P. Capt., Ordnance, U. S. A.

Davis, Chandler. Capt., Engineers, U. S. A., 6th Engrs., A. E. F., France.

Davis, Daniel E. Capt., Quartermaster Corps, U. S. A.

Davis, Frederick A. W. Capt., U. S. A., 213th Engrs.

Davis, John C. Capt., Coast Artillery, U. S. A.

Davis, Robert M. 1st Lieut., Engineers, U. S. A., 57th Engrs. (Inland Waterways).

Davy, J. J. 1st Lieut., U. S. A., 23d Engrs.

Day, Warren E. Capt., Engineers, U. S. A.

Dean, Bertram D. Capt., Engineers, U. S. A., Dept., C. and F., Headquarters, S. O. S., U. S. M. P. O. 717, A. E. F., France.

Dean, Stanley. Capt., Quartermaster Corps, U. S. A.

Dean, Willis J. 1st Lieut., Quartermaster Corps, U. S. A.

de Charms, Richard, Jr. 1st Lieut., Engineers, U. S. A., Co. A, 503d Engrs. (Service Bn.), A. E. F., France.

Dedicke, E. C. 2d Lieut., U. S. A.

Deets, Edward H. Capt., Quartermaster Corps, U. S. A.

DeGraff, Carlton R. 1st Lieut., Engineers, U. S. A.

Deiser, Norman A. 1st Lieut., Engineers, U. S. A.

De Leuw, Charles E. 1st Lieut., Engineers, U. S. A., 4th Engrs.

De Moss, Samuel. Private, School of Meteorology, Signal Corps, U. S. A.

Dennis, William F. Maj., Engineers, U. S. A. (*Unassigned*).

Dent, Elliott J. Col., Engineers, U. S. A., 26th Engrs., A. P. O. 765, A. E. F., France.

Derby, George McC. Lt.-Col., Engineers, U. S. A.

Diesem, Harry C. Capt., Engineers, U. S. A., 404th Engr. Depot Detachment.

Diffenderfer, Claude O. Capt., Engineers, U. S. A., 534th Engrs., A. E. F., France.

Dillman, George L. Maj., Engineers, U. S. A.

Dobson, Gilbert C. Capt., Engineers, U. S. A., 314th Engrs.

Dodd, Joseph H. L. 2d Lieut., B. W. I. Regt.; Burlington, St. Margaret's Bay, Jamaica.

Doebler, Valentine S. Capt., Quartermaster Corps, U. S. A.

Doeleman, H. F. Maj., Quartermaster Corps, U. S. A.

Dohm, Edward Clarence. Capt., Engineers, U. S. A.

Donahey, Joseph A. Capt., Engineers, U. S. A.

Doten, Leonard S. Capt., Quartermaster Corps, U. S. A.

Douglass, Louis R. Capt., Quartermaster Corps, U. S. A.

Dow, Hezekiah Shailer. 2d Lieut., 492d Constr. Squadron, Air Service, A. E. F., France.

Doyle, John S. Maj., Engineers, U. S. A.

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Drew, C. D. Capt., 11th Engrs. (Ry.), A. E. F., France.

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Drury, William F. Capt., Engineers, U. S. A.

Du Bois, George B. 1st Lieut., Engineers, U. S. A., Commanding 6th Engr. Train, 3d Div., A. E. F., France.

Dunlap, Walter H. 1st Lieut., Engineers, U. S. A., 109th Engrs.

Dunn, Beverly C. Maj., Engineers, U. S. A.

Dunshee, Bertram K. 1st Lieut., Engineers, U. S. A., 316th Engrs.

Du Pré, Wallace Duncan. Lieut., Quartermaster Corps, U. S. A., Mech. Repair Shop Unit No. 303.

Durham, Henry Welles. Maj., Engineers, U. S. A., 41st Engrs., A. E. F., France.

Durham, Leicester. Capt., Engineers, U. S. A., A. P. O. 733, A. E. F., France.

Dykeman, Conrad F. 1st Lieut., Engineers, U. S. A., 116th Engrs., P. O. 733, A. E. F., France.

Eager, V. M. Capt., Quartermaster Corps, U. S. A.

Eason, F. G. Capt., Engineers, U. S. A., 317th Engrs.

Easton, Russell B. Capt., Engineers, U. S. A.

Eckel, Edwin C. Capt., Engineers, U. S. A., Headquarters, A. E. F., France.

Eddy, Albert C. Capt., 55th Engrs., A. E. F., France.

Eddy, Harold M. Lieut., Civil Engineer Corps, U. S. N. R. F.

Edgerton, G. E. Col., Engineers, U. S. A.

Edmondson, Ralph S. 1st Lieut., U. S. A., 27th Engrs. (Min.).

Edmonston, A. D. 2d Lieut., Engineers, U. S. A.

Edwards, G. G. Capt., Engineers, U. S. A., Co. F, 315th Engrs.

Elliott, J. W. Capt., Engineers, U. S. A., Co. A, 602d Engrs.

Elliott, Malcolm. Lt.-Col., Engineers, U. S. A., 309th Engrs., 84th Div., A. E. F., France.

Elliott, Percival. Private, Co. D, 33d Engrs.

Ellison, Alexander H. 1st Lieut., Engineers, U. S. A., 3d Bn., 20th Engrs. (Forestry).

Embury, Aymar, 2d. Capt., Engineers, U. S. A., Camouflage Section, A. E. F., France.

Emerson, Raffe. Ensign, Flying Corps, U. S. N. R. F.

Endicott, Mordecai T. Rear-Admiral, Civil Engineer Corps, U. S. N.

Enger, Arthur L. Capt., Engineers, U. S. A.

Ernst, Oswald H. Maj.-Gen., U. S. A. (*Retired*).

Estes, F. E. Capt., 17th Engrs. (Ry.), A. E. F., France.

Everett, Chester McK. Capt., Sanitary Corps, U. S. A.

Everett, Ralph B. Private, Co. F, 23d Engrs., A. E. F., France.

Everham, Arthur C. Maj., Quartermaster Corps, U. S. A.

Fahy, Joseph Augustine. Capt., Engineers, U. S. A., Co. D, 518th Engrs., A. P. O. 752, A. E. F., France.

Fairchild, John F. Maj., Quartermaster Corps, U. S. A., Brigade Headquarters, 1st Corps Troops.

Fairlie, John Walter. 1st Canadian Exp. Force (*Retired*).

Fairman, James Robert. Capt., Engineers, U. S. A.

Falk, Myron S. Maj., Ordnance, U. S. A.

Farley, M. M. 1st Lieut., Engineers, U. S. A.

Farrin, James M. Capt., Engineers, U. S. A.; Adjt., 6th Bn., 20th Engrs., A. E. F., France.

Fassett, Earle W. 1st Lieut., Engineers, U. S. A., 316th Engr. Train.

Feigel, John H. 1st Lieut., Engineers, U. S. A., A. E. F., France.

Feiner, Mark A. Meteorological Section, Signal Corps, Aviation Section, U. S. A.

Feltham, Percy M. Capt., Engineers, U. S. A.

Ferguson, Harry Foster. 1st Lieut., Engineers, U. S. A., O. C. E. O., Adv. Sec., L. of C., A. P. O. 714, A. E. F., France.

Fernald, Gordon H. Capt., Engineers, U. S. A., Co. D, 304th Engrs.

Fickes, Clark R. Maj., Engineers, U. S. A., A. E. F., France.

Fiebeger, G. J. Col., U. S. A., Headquarters, A. E. F.

Fifer, Frank P. Capt., Engineers, U. S. A., Lines of Communications, A. E. F., France.

Finley, C. MacF. Capt., Engineers, U. S. A., 503d Service Bn., A. E. F., France.

Finnell, Woolsey. Maj., Engineers, U. S. A., 501st Engrs., U. S. A. P. O. 741, A. E. F., France

Fisher, George Joseph. Lieut., U. S. A., Co. E, 219th Engrs.

Fisher, Janon. Maj., Engineers, U. S. A., 522d Engrs.

Fisk, Clinton H. Maj., Quartermaster Corps, U. S. A.

FitzGerald, C. C. Maj., Engineers, U. S. A., 32d Engrs.

Fitzgerald, Gerald C. 1st Lieut., Engineers, U. S. A., 319th Engrs.

Fitzpatrick, F. J. Capt., Engineers, U. S. A., Co. C, Service Bn., 508th Engrs., A. E. F., France.

Flagg, Herbert J. Capt., Coast Artillery, U. S. A.

Flagler, C. A. F. Brig.-Gen., U. S. A., 5th F. A. Brigade, A. E. F., France.

Fleming, Burton P. Capt., Engineers, U. S. A.

Flick, John K. Capt., Engineers, U. S. A.

Flook, Lyman R. 1st Lieut., Ordnance, U. S. A.

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Follin, James W. 1st Lieut., Sanitary Corps, U. S. A.

Fölling, B. N. Capt., Engineers, U. S. A., Co. A, 49th Engrs., A. E. F., France.

Foote, Olney N. Lieut., U. S. A., Co. G, 322d Inf.

Forbes, Francis B. 1st Lieut., Engineers, U. S. A.

Ford, William Ellis. Capt., Engineers, U. S. A.

Forster, Arthur Oscar. Capt., Quartermaster Corps, U. S. A.

Forter, Cecil A. 1st Lieut., Sanitary Corps, U. S. A.

Forter, Samuel A. Lieut., U. S. N. R. F.; Public Works Officer, U. S. Naval Air Station, Gironde, France.

Fortney, C. Page. Capt., Engineers, U. S. A.

Foster, Ernest H. Ensign, U. S. N. R. F.

Foster, Samuel D. 1st Lieut., U. S. A., and A. D. C., Headquarters, 53d Artillery Brigade.

Fouilhoux, J. Andre. Capt., Field Artillery, U. S. A.

Fountain, Thomas L. Capt., Engineers, U. S. A., Care, C. O., 17th Engrs. (Ry.), U. S. A. P. O. 701, A. E. F., France.

Fowler, Charles Worthington. 1st Lieut., Signal Corps, Aviation Section, U. S. A., Commanding 485th Aero Constr. Squadron, A. E. F., France.

Fox, Henry. Capt., Engineers, U. S. A., 314th Engrs.

Fox, Stephenson W. Maj., Engineers, U. S. A.

Frank, George Stedman. Lieut., Signal Corps, Aviation Section, U. S. A., A. E. F., France.

Franklin, William H. 1st Lieut., Quartermaster Corps, Constr. Div., U. S. A.

Franks, John B. 1st Lieut., U. S. A., 7th F. A.

Freeman, William B. Capt., Engineers, U. S. A., Co. A, 509th Engrs. (Service Bn.)

French, F. C. Capt., Engineers, U. S. A., 525th Engrs.

Friedman, Harry B. Lieut., Signal Corps, Aviation Section, U. S. A.

Fries, Amos A. Col., U. S. A., 30th Engrs.; Chf. of Gas Service, A. E. F., France.

Froiseth, Richard E. 1st Lieut., Engineers, U. S. A.

Frost, Edward M. Asst. Civ. Engr., U. S. N. R. F.

Fry, Alfred Brooks. Capt., U. S. N. N. V.

Furlow, Felder. Capt., Engineers, U. S. A.

Fyfe, James Lincoln. Maj., Quartermaster Corps, U. S. A.

Gabelman, Charles G. Lieut., Engineers, U. S. A., Co. 1, E. O. T. S., Camp Humphreys, Va.

Gailor, Chester F. Maj., Quartermaster Corps, U. S. A.

Galbreath, Albert W. 1st Lieut., Engineers, U. S. A., Co. B, 12th Engrs. (Ry.), A. E. F., France.

Gallagher, Leonard Bruce. 2d Lieut., Engineers, U. S. A., Ry. Transportation Corps, U. S. A. P. O. 717, A. E. F., France.

Galloway, John D. Maj., Engineers, U. S. A., A. E. F., France.

Galvin, James Augustine. 1st Lieut., Engineers, U. S. A.; Engr. Officer, Army General Staff Coll., U. S. A. P. O. No. 714, A. E. F., France.

Garnett, Benjamin J. 1st Lieut., Engineers, U. S. A. (*Unassigned*), A. E. F., France.

Garrett, Robert P. Capt., Ordnance, U. S. A.

Gartensteig, Charles. Capt., Engineers, U. S. A., 535th Engrs.

Gatens, Ray S. 1st Lieut., Engineers, U. S. A., Co. C, 42d Engrs., A. E. F., France.

Gausmann, Roy W. Maj., Engineers, U. S. A., 303d Engrs., A. E. F., France.

Gayler, E. R. Commander, Civil Engineer Corps, U. S. N., Port au Prince, Haiti.

Geib, George Albert. Capt., Engineers, U. S. A., Co. A, 527th Engrs., Service Bn.

Genung, J. H., Jr. Lieut., Engineers, U. S. A.

George, Howard H. Capt., Engineers, U. S. A., Co. E, 305th Engrs.

Getty, Lorenzo T. 1st Lieut., Signal Corps, Aviation Section, U. S. A., 75th Aero Constr. Squadron, A. E. F., France.

Gibbs, E. A. Maj., 15th U. S. Engrs. (Ry.), A. E. F., France.

Gibbs, William Wetmore. 1st Lieut., Engineers, U. S. A.

Gibson, Thomas F. Corporal, Headquarters Co., 63d Inf.

Giesen, Walter E. Private, U. S. Marine Corps, Co. 269, Bn. W.

Giesting, Frank A. Maj., Engineers, U. S. A., 302d Engrs.

Giffels, William C. 1st Lieut., Engineers, U. S. A.

Gilman, E. Dow. 1st Lieut., Engineers, U. S. A., 473d Engrs.

Gladding, James N. Capt., Engineers, U. S. A. (*Unassigned*), A. E. F., France.

Glander, John Henry, Jr. Ensign, Civil Engineers Corps, U. S. N. R. F.

Glazier, W. L. Maj., Engineers, U. S. A.; Commanding Officer, 525th Engrs., Service Bn., A. E. F., France.

Goddard, Leslie Drew. Capt., Engineers, U. S. A.

Godfrey, Alex. H. Asst. Paymaster, U. S. N. R. F.

Godfrey, Stuart C. Lt.-Col., Engineers, U. S. A., Headquarters, 318th Engrs., A. E. F., France.

Goethals, George R. Col., U. S. A.; Engr. Officer, Headquarters, Army Artillery, 1st Army, A. E. F., France.

Goethals, George W. Maj.-Gen., U. S. A.

Golden, William A. Ensign, U. S. N. R. F., U. S. S. *Mary Alice*.

Goldsmith, Clarence. Maj., Quartermaster Corps, U. S. A.

Gooch, Carl Joseph. Co. E, 32d Engrs.

Goodman Benjamin. 2d Lieut., Engineers, U. S. A., 504th Engrs., Headquarters, A. E. F., France.

Goodman, Leon. Capt., U. S. A., and Adjt., 109th Engrs.

Gordon, John Blake. Care, Chf. Engr. Officer, General Headquarters, A. E. F., France.

Gordon, Samuel. Lt-Commander, Civil Engineer Corps, U. S. N.

Goss, O. P. M. Capt., Signal Corps, Aviation Section, U. S. A.

Gotwals, John C. Lt.-Col., Engineers, U. S. A., Care, O. C. E., G. H. Q., A. P. O. 706, A E. F., France.

Gough, William J. Capt., Engineers, U. S. A.

Gould, William T. Capt., Engineers, U. S. A., U. S. M. P. O. 705, A. E. F., France.

Gow, C. R. Maj., Quartermaster Corps, U. S. A.

Grady, Frank L. Sergeant, Co. I, 52d Pioneer Inf.

Graff, George W. Candidate, Field Artillery Central Officers' Training School, 29th Training Battery, Camp Zachary Taylor, Ky.

Grant, John R. Maj., M. C., R. E., Offizier-Gefangenenlager, Stralsund (Danholm), Germany.

Grant, Kenneth C. Maj., Quartermaster Corps, U. S. A.

Grant, U. S., 3d. Col., U. S. A.

Gravell, William Henry. Capt., Engineers, U. S. A., A. E. F., France.

Graves, E. M. Maj., Engineers, U. S. A., 529th Engrs.

Gray, Earle P. 1st Lieut., Engineers, U. S. A., 16th Engrs. (Ry.), A. E. F., France.

Gray, William B. Maj., Engineers, U. S. A.

Green, Charles N. Maj., Engineers, U. S. A.

Green, Clarence Jasper. 1st Lieut., Oregon Coast Artillery.

Green, F. W. Lt.-Col., Transportation Corps, U. S. A.; Gen. Supt., Army Transport Service, A. E. F., France.

Greene, F. S. Capt., U. S. A., Co. B, 302d Engrs.

Greenfield, Robert A. Maj., Engineers, U. S. A.

Gregory, John H. Capt., Sanitary Corps, U. S. A.

Gregory, Luther E. Capt., Civil Engineer Corps, U. S. N.

Gregory, William B. Maj., Engineers, U. S. A., A. E. F., France.

Grehan, Bernard H. 1st Lieut., U. S. A., 312th Engrs.

Griest, Maurice. 1st Lieut., Engineers, U. S. A.

Griffin, John Alden. Capt., U. S. A., Co. A, 316th Engrs.

Grigsby, Walter B. 1st Lieut., Engineers, U. S. A., 9th Engrs. (Mounted).

Grimes, James E. Capt., Quartermaster Corps, U. S. A.

Grindrod, Irvin S. 1st Lieut., Engineers, U. S. A. (*Unassigned*).

Griswold, Harry T. 2d Lieut., Coast Artillery, U. S. A.

Griswold, Hector C. Lieut. (Junior Grade), Civil Engineer Corps, U. S. N.

Griswold, Lee S. Capt., Engineers, U. S. A. (*Unassigned*).

Grodske, Walter J. Capt., Engineers, U. S. A.

Gross, Frederick H. 2d Lieut., Engineers, U. S. A., Co. B, 303d Engrs.

Gross, Henry McC. 1st Lieut., 149th Div., Machine Gun Bn., A. E. F., France.

Grunauer, Mortimer. Sergeant, Headquarters Co., 304th F. A., A. E. F., France.

Guillemette, Joseph D. 2d Lieut., Air Service, U. S. A., Air Service Depot No. 1, A. P. O. 702, A. E. F., France.

Gunther, Herman Dietrich. Co. B, 147th Inf.

Guppy, Benjamin Wilder. Maj., Engineers, U. S. A., 14th Engrs. (Ry.), A. E. F., France.

Guptill, Joseph R. Private, Co. E, 2d Bn., 23d Engrs., A. E. F., France.

Gutman, David. Maj., Engineers, U. S. A.

Haas, Philip L. Capt., Engineers, U. S. A.

Hadley, Allen S. 1st Lieut., Engineers, U. S. A.

Hains, Peter C. Maj.-Gen., U. S. A.

Halcombe, N. M. Capt., Royal Flying Corps, Egypt.

Haldeman, Walter S. Capt., Engineers, U. S. A.

Hale, Richard King. Lt.-Col., 101st F. A., A. E. F., France.

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Hallberg, Arthur S. 1st Lieut., U. S. N. R. F., U. S. S. *Quinnebaug.*

Hallihan, John P. Maj., Engineers, U. S. A.

Halsema, E. J. Capt., Engineers, U. S. A.

Hamilton, Edward P. 2d Lieut., Field Artillery, U. S. A., 306th F. A.

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Hanavan, William L. 1st Lieut., 9th Inf.; Adjt., 2d Bn., A. E. F., France.

Hancock, Henry Sydney, Jr. Lieut., Royal Engrs.; Field Engr., First Corps, B. E. F., France.

Hanique, Jules E. Maj., Engineers, U. S. A., 537th Engrs., A. E. F., France.

Hannan, David E. Capt., Engineers, U. S. A., A. E. F., France.

Hansen, Paul. Capt., Engineers, U. S. A. Headquarters, Advance Section, S. O. S., Office of Chf. Engr., A. E. F., France.

Hapgood, Frederic H. Co. A, 26th Engrs., A. E. F., France.

Hardaway, Benjamin H., Jr. Maj., U. S. A.

Harding, Chester. Lt.-Col., Engineers, U. S. A., Balboa Heights, Canal Zone, Panama.

Harding, Ralph L. Capt., Engineers, U. S. A., 35th Engrs.

Harley, Alfred F. Field Clerk, Engineers, U. S. A., A. E. F., France.

Harmon, W. G. Capt., Sanitary Corps, U. S. A.

Harrah, O. W. Capt., Engineers, U. S. A., 319th Engrs.

Harris, F. R. Rear-Admiral, U. S. N.

Harris, Frank S. M. Lieut. (Senior Grade), U. S. N. N. V.

Harrison, William Burr. Maj., Engineers, U. S. A.

Hart, S. A. 1st Lieut., Engineers, U. S. A., 23d Engrs.

Harter, A. F. Capt., Engineers, U. S. A.

Harts, William W. Brig.-Gen., U. S. A., G. H. Q., 1er Echelon, B. E. F., France.

Hasbrouck, Oscar. Capt., Engineers, U. S. A., 522d Engrs.

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Hayes, F. Eugene, Jr. Chf. Carpenter's Mate, U. S. N.

Hays, Donald S. Capt., Engineers, U. S. A.

Hays, John Coffee. Maj., Quartermaster Corps, U. S. A.

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Heed, Samuel D. Capt., Ordnance, U. S. A.

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Heuer, W. H. Col., U. S. A. (*Retired*).

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Holt, Andrew H. Capt., Engineers, U. S. A.

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Howell, Clarence S. Capt., Engineers, U. S. A.

Howell, George P. Col., Engineers, U. S. A.

Howell, Robert P. Capt., Quartermaster Corps, U. S. A.

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Jaenicke, William H. 2d Lieut., Engineers, U. S. A.

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Johnson, George A. Maj., Quartermaster Corps, U. S. A.

Johnson, Halbert T. Sergeant, 472d Engrs.

Johnson, Hollister. 2d Lieut., Engineers, U. S. A., Co. C, 1st Bn., 20th Engrs., A. E. F., France.

Johnson, J. M. Lt.-Col., 117th Engrs., A. E. F., France.

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Jones, Harry E. Private, Aviation Section, Signal Corps, U. S. A., Meteorological Section.

Jones, Henry L. Maj., Engineers, U. S. A. (*Unassigned*).

Jones, John H. Capt., 1st Canadian Pioneers, B. E. F., France.

Jones, Jonathan. Capt., Engineers, U. S. A., 23d Engrs.

Jones, Lewis Allen. Capt., Engineers, U. S. A.

Jones, Paul Sidney. Co. 2, E. O. T. C., Camp Humphreys, Va.

Jones, Percival C. Corporal, Co. G, 23d U. S. Engrs., A. P. O. 716, A. E. F., France.

Jones, Sidney G. Capt., Engineers, U. S. A., Headquarters Co., 35th Engrs., A. P. O. 735, A. E. F., France.

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Kane, Daniel C. 1st Lieut., Engineers, U. S. A., 466th Pontoon Train.

Kane, Irving P. Capt., Engineers, U. S. A., 45th Engrs., A. E. F., France.

Karnopp, Edwin B. Capt., Engineers, U. S. A., 2d Bn., 22d Engrs.

Kastenhuber, E. G., Jr. Capt., Sanitary Corps, U. S. A.

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Keith, Gerald Marcy. Lieut., Engineers, U. S. A., Co. B, 116th Engrs., A. E. F., France.

Keller, Arthur R. Capt., Engineers, U. S. A.

Keller, Charles. Col., Engineers, U. S. A.

Kelly, Earl W. Capt., Engineers, U. S. A., 4th Bn., 116th Engrs., A. P. O. 733, A. E. F., France.

Kelly, Hugh Ambrose. Lieut., Engineers, U. S. A.

Kelly, William. Col., Engineers, U. S. A., 117th Engrs., A. E. F., France.

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Khachadoorian, H. H. 1st Lieut., Engineers, U. S. A., Co. C, 55th Engrs.

King, Clifford M. Capt., Engineers, U. S. A., 313th Engrs.

King, Eric T. Maj., Quartermaster Corps, U. S. A.

King, Howard L. 2d Lieut., Engineers, U. S. A., Co. B, 27th Engrs.

King, Thomas R. 1st Lieut., Engineers, U. S. A., 116th Engrs., A. P. O. 733, A. E. F., France.

King, W. S. Capt., Quartermaster Corps, U. S. A.

Kingsley, E. A. Maj., Engineers, U. S. A., A. E. F., France.

Kingsley, George. Capt., Engineers, U. S. A.

Kinne, G. W. Capt., Engineers, U. S. A.

Kinnear, Lawrence W. 2d Lieut., Aviation Section, Signal Corps, U. S. A.

Kipp, Frederick M., Jr. 33d Engrs., U. S. A.

Kirby, Luther H. Capt., Engineers, U. S. A.

Kirschner, Charles. Student (Private), E. O. T. S., Camp Humphreys, Va.

Kissack, A. B. Capt., Engineers, U. S. A.

Kitchen, Ernest. 1st Lieut., Engineers, U. S. A.

Kittredge, Frank A. Capt., U. S. A., 43d Engrs., A. E. F., France.

Kittredge, Harry C. Capt., Engineers, U. S. A.

Kitts, Joseph A. Capt., Engineers, U. S. A., U. S. A. P. O. 701, A. E. F., France.

Kleinschmidt, H. S. Capt., Engineers, U. S. A.

Klinck, J. H. Maj., Quartermaster Corps, U. S. A.

Kluegel, Harry A. Capt., Quartermaster Corps, U. S. A.

Knight, G. W. Capt., Engineers, U. S. A., 46th Engrs., A. E. F., France.

Kniskern, Philip Wheeler. Capt., Engineers, U. S. A.

Knollman, Enno P. Ensign, U. S. N. R. F.

Knost, W. A. 1st Lieut., Coast Artillery, U. S. A.

Knox, Jean H. Lieut., U. S. N. R. F., Care, U. S. Naval Aviation Forces, Paris, France.

Koop, Louis D. Capt., Quartermaster Corps, U. S. A.

Krach, Fred R. Private, Co. A, 23d Engrs.

Kreamer, A. W. 1st Lieut., Engineers, U. S. A. (*Unassigned*).

Krigbaum, Lowell G. 1st Lieut., Engineers, U. S. A., Care, Director of C. and F., A. E. F., France.

Kromer, Clarence H. 1st Lieut., U. S. A., 403d Engrs.

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La Bach, Paul M. Maj., Engineers, U. S. A., A. E. F., France.

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La Forge, Frederick W. Maj., Engineers, U. S. A.

Lake, Edward N. Maj., Quartermaster Corps, U. S. A.

Lamb, Lyman C. Capt., Engineers, U. S. A.

Lambert, Byron J. Maj., Engineers, U. S. A., 23d Engrs. (Highway).

Lamphere, Frank E. Col., Quartermaster Corps, U. S. A.

Lamson, William M. Maj., Engineers, U. S. A., 306th Engrs.

Lancashire, Forest H. Capt., Engineers, U. S. A.

Land, John T. Capt., Engineers, U. S. A.

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LeBaron, R. W. P. 1st Lieut., Co. C, 13th Engrs. (Ry.), A. E. F., France.

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Lee, Charles A. Lieut. (Senior Grade), U. S. N. R. F.

Lee, Charles H. 1st Lieut., Engineers, U. S. A., Care, Chf. Engr. Officer, A. E. F., A. P. O. 717, Water Supply Section, A. E. F., France.

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McGrew, John A. Maj., Quartermaster Corps, U. S. A.

McIntosh, Samuel F. Capt., Ordnance, U. S. A.

McIntyre, Lewis W. 2d Lieut., Coast Artillery, U. S. A.

McKay, George A. Commander, Civil Engineer Corps, U. S. N.

McKenney, Charles A. Col., Engineers, U. S. A.

McKinstry, Charles Hedges. Brig.-Gen., U. S. A., 67th F. A. Brigade, A. E. F., France.

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McRae, H. C. 1st Lieut., Engineers, U. S. A., 45th Engrs., A. E. F., France.

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Mandigo, Clark R. Capt., Engineers, U. S. A., 314th Engrs.

Mangold, John Frederic. Capt., Engineers, U. S. A. (*Unassigned*).

Manning, William J. H. 2d Lieut., Engineers, U. S. A., 52d Engrs., A. E. F., France.

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Marston, Anson. Maj., Engineers, U. S. A.

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Ober, Ralph H. Capt., Engineers, U. S. A.

Odoni, Vincent P. Ensign, U. S. N. R. F.

Okes, Day I. Capt., Engineers, U. S. A., and Adjt., 42d Engrs.

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Peck, John S. Private, U. S. A., S. M. A., Photo. Div.

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Rossell, Paul Francis. Capt., Engineers, U. S. A.; Adjt., 2d Bn., 23d Engrs., A. E. F., France.

Rothrock, W. P. Maj., Engineers, U. S. A.

Rousseau, Harry Harwood. Rear-Admiral, Civil Engineer Corps, U. S. N.

Rowe, Donald H. Lieut., Engineers, U. S. A.

Rowland, James W. Capt., Engineers, U. S. A., 214th Engrs.

Royal, Joseph N. 2d Lieut., Engineers, U. S. A., Headquarters, 53d Engrs.

Royall, Edward M. Asst. Civ. Engr., U. S. N. R. F.

Ruggles, Arthur V. Capt., Engineers, U. S. A., 17th Engrs., A. E. F., France.

Russell, Claud. Capt., Co. 7, E. O. T. S., Camp Humphreys, Va.

Russell, William Hepbourne. 1st Lieut., U. S. A., 5th F. A.

Ruth, Edgar K. Capt., Engineers, U. S. A.

Ryan, Walter J. Capt., Engineers, U. S. A.

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Sadler, Carl L. Capt., Engineers, U. S. A.

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Salisbury, Alfred J., Jr. 1st Lieut., A. S. P., U. S. A., Aero Squadron No. 498.

Sample, William D. Corporal, 60th Trench Mortar Battery, B. E. F., France.

Sanger, Walter M. Capt., Engineers, U. S. A., A. E. F., France.

Sargent, Edward H. Capt., Engineers, U. S. A., 116th Engrs., A. E. F., France.

Sargent, J. A. Capt., Engineers, U. S. A., Care, Headquarters, Lines of Communications, A. E. F., France.

Sawyer, Charles L. 1st Lieut., Engineers, U. S. A.

Scammell, John Kimball. Lieut., 13th Reserve Bn., Canadian, Seaford, Sussex Co., England.

Schanck, F. R. Maj., Ordnance, U. S. A.

Scharff, Maurice R. 1st Lieut., Engineers, U. S. A.; Office, D. C. and F., S. O. U., S. O. S., A. E. F., France.

Scheidenhelm, F. W. Capt., Engineers, U. S. A., Care, Chf. Engr., A. E. F., France.

Schermerhorn, Richard, Jr. Capt., Sanitary Corps, U. S. A.

Schmucker, Beale M. 1st Lieut., U. S. A., 104th Engrs.

Schoder, Ernest W. Capt., Engineers, U. S. A.

Scholtz, H. F. Capt., Engineers, U. S. A.

Schoonmaker, Leon M. Capt., Engineers, U. S. A.

Schroeder, Seaton, Jr. Lieut. (Junior Grade), Civil Engineer Corps, U. S. N. R. F.

Schwartz, Lloyd. Acting Master Gunner, Headquarters Co., 72d Artillery Regt.

Schwendener, K. DeW. Capt., U. S. A., 115th Engrs.

Scott, Lewis P. 1st Lieut., Engineers, U. S. A.

Scudder, Charles Morrison. Capt., Co. E, 107th Engrs., A. E. F., France.

Scudder, Henry D., Jr. 2d Lieut., United States Guards, U. S. A.

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Seage, Clarence E. Ensign, U. S. N.

Seelye, Seth H. Co. G, 23d Engrs., A. E. F., France.

Selander, John E. Maj., Royal Engrs., Care A. D. Rys., B. E. F., Italy.

Senior, Frank S. Maj., Railroad Transportation Corps, U. S. A., Care, Director General of Transportation, A. E. F., France.

Sessler, Grover C. Asst. Civ. Engr., U. S. N. R. F.

Seward, Oscar A., Jr. Capt., Engineers, U. S. A., 315th Engrs.

Sewell, John Stephen. Col., Engineers, U. S. A., Commanding Base Section No. 1, A. E. F., France.

Sexton, George F. Sergeant, 1st Class.

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Shafer, Ernest Alton. 1st Lieut., Engineers, U. S. A.

Shafer, J. C. F. Capt., Coast Artillery, U. S. A., A. E. F., France.

Shankland, Ralph Graham. 1st Lieut., Engineers, U. S. A.

Shaw, Arthur Lassell. Capt., Engineers, U. S. A., 301st Engrs.

Shaw, Arthur M. Maj., Engineers, U. S. A., Mech. Repair Unit No. 305.

Shaw, Franklin Dickinson. Capt., Engineers, U. S. A.

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Starrett, William A. Col., Quartermaster Corps, U. S. A.

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Stearns, Fred LeRoy. Lieut., U. S. A., Co. A, 107th Inf.

Stearns, Ralph H. Lieut. (Junior Grade), U. S. N. R. F.

Steep, James B. Capt., Engineers, U. S. A.

Steese, James Gordon. Col., Engineers, U. S. A., General Staff.

Steeves, C. McN. Lieut., 9th Field Co., Canadian Engrs., B. E. F., France.

Steinhauser, H. H. 2d Lieut., Air Service, U. S. A. (Aeronautics); Engr. Officer, 346th Handley-Page Service Squadron.

Stellhorn, Adolf. Capt., Engineers, U. S. A., Office, Chf. Engr., S. O. R., P. O. 717, A. E. F., France.

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Stephens, Uel. Lieut., U. S. A., 57th Inf.

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Stewart, John T. Maj., Engineers, U. S. A.

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Stickle, H. W. Lt.-Col., U. S. A. (*Retired*).

Stidham, Harrison. Capt., Quartermaster Corps, U. S. A., Constr. Div.

Stillwell, Howard L. 2d Lieut., Quartermaster Corps, U. S. A.

Stineman, Norman M. Capt., Engineers, U. S. A., Co. D, 33d Engrs., A. E. F., France.

Stivers, A. D. Capt., Infantry, U. S. A.

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Stupp, John G. 1st Lieut., C. W. S., U. S. A.

Sturtevant, C. W. Lt.-Col., U. S. A., 15th Engrs., A. E. F., France.

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Suter, Russell. Capt., Engineers, U. S. A., Care, S. E. O., Int. Sect., S. O. S., A. E. F., France.

Sutton, Frank. Maj., Engineers, U. S. A., 29th Engrs.

Swaren, J. W. Maj., Engineers, U. S. A.,

Swartz, Leon. Master Engr., 15th U. S. Engrs., A. E. F., France.

Sweeney, Harry C. Capt., Quartermaster Corps, U. S. A.

Sweetser, C. H. Capt., Engineers, U. S. A., Co. A, 43d Engrs., A. E. F., France.

Sweetser, E. O. Capt., Engineers, U. S. A. (*Unattached*), A. E. F., France.

Swett, Everett H. Capt., Engineers, U. S. A.

Sykes, George. Capt., Engineers, U. S. A., A. E. F., France.

Symonds, G. R. B. Capt., Engineers, U. S. A., Co. A, 605th Engrs.

Tainter, F. S. Maj., Engineers, U. S. A.

Talbot, K. H. Capt., Quartermaster Corps, U. S. A.

Tandrow, Walter S. 1st Lieut., Engineers, U. S. A.

Tate, R. L. Capt., Engineers, U. S. A.; Adjt., 1st Bn., 303d Engrs., A. E. F., France.

Tay, S. W. Lieut., U. S. N. N. V., U. S. S. *Wenonah.*

Taylor, Arthur. 1st Lieut., Engineers, U. S. A.

Taylor, Edwin A. Maj., Engineers, U. S. A., 526th Engrs., A. E. F., France.

Taylor, Harry. Brig.-Gen., U. S. A.; Chf. Engr., A. E. F., France.

Taylor, Henry. Capt., Engineers, U. S. A., 304th Engrs.

Taylor, Hugh M. Maj., U. S. A., Care, D. G. T., A. P. O. 762, A. E. F., France.

Taylor, Nelson. Lieut., U. S. N., U. S. S. *Bridgeport.*

Taylor, P. M. 2d Lieut., R. E., 237th Field Co., B. E. F., Italy.

Taylor, Seneca V. Capt., Coast Artillery, U. S. A.

Taylor, William T. Capt., Royal Flying Corps, B. E. F., France.

Taylor, Wyllys H. Capt., Engineers, U. S. A., 306th Engrs.

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Thomas, William Michael. Capt., Engineers, U. S. A.

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Thompson, Sanford E. Maj., Engineers, U. S. A.

Thompson, Wilford Ashford. 1st Lieut., Co. 2, E. O. T. S., Camp Humphreys, Va.

Thomsen, S. L. Capt., Engineers, U. S. A., Co. A, 57th Engrs., A. E. F., France.

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Throop, George H. Capt., Engineers, U. S. A., Co. E, 24th Engrs.

Thurber, Clinton D. Commander, Civil Engineer Corps, U. S. N.

Thurston, Eugene T. Capt., Engineers, U. S. A.

Tilden, Charles Joseph. Capt., Engineers, U. S. A. (*Unassigned*).

Tinkham, Ralph R. Capt., Engineers, U. S. A., 420th Engrs.

Tinsley, R. B. Capt., Engineers, U. S. A., Co. C, 605th Engrs., A. E. F., France.

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Todd, Frank Herbert. Maj., Quartermaster Corps, U. S. A.

Todd, Oliver J. Capt., Engineers, U. S. A., A. P. O. No. 780, A. E. F., France.

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Topping, Perry. Capt., Engineers, U. S. A., 5th Engrs.

Torrance, William M. Capt., Engineers, U. S. A.

Townsend, C. McD. Col., Engineers, U. S. A., 12th Engrs. (Ry.), A. E. F., France.

Toyne, John Wilson. Capt., Quartermaster Corps, U. S. A.

Tracy, C. C. Capt., Coast Artillery, U. S. A.

Tracy, Herbert Herman. 1st Lieut., Engineers, U. S. A., Engr. Wagon Co. 4, 23d Engrs., U. S. A. P. O. 708, A. E. F., France.

Travers-Ewell, Andrew. Care, American Consul, Para, Brazil.

Treser, Albert Paul. 605th Engrs., A. E. F., France.

Trimpi, Allan Littell. 1st Lieut., U. S. A., 104th Engrs.

Trout, Alexander Linn. Capt., Engineers, U. S. A. (*Unassigned*), A. E. F., France.

True, Albert O. Capt., Engineers, U. S. A.

Trueblood, P. McG. Lieut., U. S. N. R. F.

Tucker, H. F. Ensign, U. S. N. R. F.

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Tyler, Richard G. Capt., Quartermaster Corps, U. S. A.

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Van Buren, Maurice Pelham. Capt., Engineers, U. S. A., 602d Engrs.

Vandemoer, N. C. Capt., Engineers, U. S. A.

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Vandevanter, Elliott. Capt., Engineers, U. S. A., Co. D, 503d Engrs., A. E. F., France.

Van Ness, R. A. Lieut., Engineers, U. S. A.

Van Pelt, Sutton. Capt., Engineers, U. S. A., 110th Engrs.

Van Suetendael, Achille O. Capt., Engineers, U. S. A.

Van Zile, Harry Lee. Maj., Engineers, U. S. A., A. E. F., France.

Vaughan, Henry F. Capt., Sanitary Corps, U. S. A.

Vernon, Stephen B. Capt., Engineers, U. S. A. (*Unassigned*).

Verrill, George E. Maj., Engineers, U. S. A.

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Walker, Meriwether Lewis. Col., Engineers, U. S. A., G. H. Q., A. E. F., France.

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Waugh, William H. Maj., Engineers, U. S. A.

Way, W. F. 2d Lieut., Co. D, 18th Engrs. (Ry.), U. S. Army Post Office No. 705, A. E. F., France.

Weaver, C. J. 1st Lieut., Engineers, U. S. A.

Weaver, Earll Chase. Asst. Civ. Engr., U. S. N. R. F.

Weaver, Frank L. Capt., Engineers, U. S. A., 305th Engrs.

Webb, Claude A. Lieut., Field Artillery, U. S. A., A. E. F., France.

Webb, De Witt Clinton. Lt.-Commander, Civil Engineer Corps, U. S. N.

Webb, George H. Lt.-Col., 16th U. S. Engrs. (Ry.), A. E. F., France.

Webb, I. Gano. Capt., Engineers, U. S. A.

Webb, Walter Loring. Maj., Engineers, U. S. A., A. E. F., France.

Webster, Maurice A. Capt., Ordnance, U. S. A.

Weeks, W. C. Maj., Engineers, U. S. A., 32d Engrs., Care, Y. M. C. A. Hotel for Officers, Paris, France.

Welden, Ernest. Private, Co. A, 43d Engrs., A. E. F., France.

Welles, Theodore L., Jr. 2d Lieut., Engineers, U. S. A.

Wells, Emery. 1st Lieut., Engineers, U. S. A., A. P. O. 712, A. E. F., France.

Welsh, Russell D. Private, Co. F, 115th Engrs., A. E. F., France.

Wenige, Arthur E. Maj., Engineers, U. S. A., 317th Engrs.

Wenzell, Andrew P. Capt., Co. F, 16th U. S. Engrs. (Ry.), A. E. F., France.

West, Edward Hazzard. Capt., Engineers, U. S. A., 5th Engrs.

West, Wade C. Capt., Engineers, U. S. A.

Wheat, G. Neville. Capt., Engineers, U. S. A.

Wheeler, Edgar True. Capt., U. S. A., 125th Engrs.

Wheeler, Frank I. 2d Lieut., Aviation Section, Signal Corps, U. S. A.

Wheeler, Robert C. Capt., Quartermaster Corps, U. S. A.

Wheelock, De Forest A. Col., U. S. A.

Whiteaker, Robert O. Capt., U. S. A., 132d F. A.

Whitman, Ezra B. Maj., Quartermaster Corps, U. S. A.

Whitman, Ralph. Lt.-Commander, Civil Engineer Corps, U. S. N.

Whitney, C. S. Corporal, Co. F, 25th Engrs., A. P. O. 705, A. E. F., France.

Whitney, John T. 2d Lieut., Field Artillery, U. S. A., 2d Corps Artillery Park, A. E. F., France.

Whitney, Ralph Edward. 1st Lieut., Sanitary Corps, U. S. A.

Whitsit, Lyle A. Capt., Engineers, U. S. A.

Whitwell, E. Capt., General Service Staff, British War Office, Robert Treat Hotel, Newark, N. J.

Wickersham, John H. Maj., Engineers, U. S. A., P. O. 706, A. E. F., France.

Widdicombe, R. A. Maj., Engineers, U. S. A.

Widdicombe, Stacey H. U. S. S. M. A., Princeton, N. J.

Wiggin, Thomas H. Capt., Engineers, U. S. A., Headquarters, Lines of Communications, A. E. F., France.

Wiggins, Ralph Raymond. 1st Lieut., Aviation Section, Signal Corps, U. S. A.

Wilcox, Ernest Hardwick. Capt., Engineers, U. S. A., 543d Engrs., A. E. F., France.

Wild, H. J. Maj., Engineers, U. S. A.

Wildish, Frederic Newton. Capt., Engineers, U. S. A., Co. B, 309th Engrs.

Wilgus, H. S. Maj., Engineers, U. S. A.

Wilgus, W. J. Col., Engineers, U. S. A., A. E. F., France.

Willard, George T. Private, Co. E, 318th Engrs.

Willard, N. R. Capt., Engineers, U. S. A.

Willcomb, George E. Capt., Quartermaster Corps, U. S. A.

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Williams, Samuel W. Maj., Engineers, U. S. A.

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Williamson, Lee H. 2d Lieut., Engineers, U. S. A., Co. A, 55th Engrs.

Williamson, Sydney B. Lt.-Col., Engineers, U. S. A.

Williar, Harry D., Jr. 1st Lieut., U. S. A., 1st Engrs., A. E. F., France.

Willis, Walter John. Lieut. (EDO).

Wilson, Edbert C. Capt., Engineers, U. S. A.

Wilson, Everitt W. Capt., Engineers, U. S. A., Co. A, 304th Engrs.

Wilson, Harry P. Capt., Engineers, U. S. A., 310th Engrs.

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Wilson, William R. Maj., 23d Field Co., R. E., B. E. F., France.

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Winn, Walter E. Lt.-Col., Engineers, U. S. A., 114th Engrs., A. E. F., France.

Winn, Walter S. Maj., Engineers, U. S. A.

Winton, Walter Ferrell. Capt., Field Artillery, U. S. A., 14th F. A.

Wodrich, Oscar F. Capt., Quartermaster Corps, U. S. A.

Wolff, H. H. Capt., Engineers, U. S. A., 556th Engr. Service Bn.

Wood, B. Russell. Capt., Engineers, U. S. A. (*Unassigned*), U. S. M. P. O. 733, A. E. F., France.

Wood, Frederic J. Maj., Engineers, U. S. A.

Woodard, Wilkie. Capt., Engineers, U. S. A., Co. H, 35th Engrs., A. P. O. 735, A. E. F., France.

Woodle, Bernon Tisdale. Capt., Engineers, U. S. A.

Woodruff, Charles W. 1st Lieut., U. S. A., 403d Engrs.

Woodruff, Glenn B. 1st Lieut., Engineers, U. S. A.

Woodward, Edwin C. Capt., U. S. A., 22d Engrs., A. E. F., France.

Woolworth, W. H. Capt., U. S. A., Headquarters, 2d Brigade, 1st Div., A. E. F., France.

Wooten, William P. Col., Engineers, U. S. A., Headquarters, 3d Corps, A. E. F., France.

Wright, Edward. Capt., Sanitary Corps, U. S. A.

Wright, Jesse B. Capt., Engineers, U. S. A. (*Unassigned*).

Wright, John Bertram. Capt., Engineers, U. S. A.

Wrightson, William D. Maj., Sanitary Corps, U. S A.; Chf. of San. Corps, U. S. A.

Yates, Sheldon S. Field Artillery Officers' Training Camp, Camp Zachary Taylor, Ky.

Yeo, W. H. W. Capt., Engineers, U. S. A.

Yereance, Alex. W. 1st Lieut., Co. F, 305th Engrs., A. E. F., France.

Yost, Howard McC. Maj., Engineers, U. S. A.

Young, Frederick C. Capt., Engineers, U. S. A.; Adjt., 114th Engrs.

Young, George S. Capt., Engineers, U. S. A., G-2-C, A. P. O. 784, A. E. F., France.

Young, Samuel M. Capt., Engineers, U. S. A.

Zinn, George A. Col., Engineers, U. S. A.

MEMBERSHIP

(From October 4th to November 7th, 1918)

ADDITIONS

MEMBERS		Date of Membership.
Barnes, Frank Edwin. Superv. Bldg. Valuation Engr., N. Y. C. Lines, 200 West 110th St. New York City		Oct. 8, 1918
Boardman, Horace Prentiss. Prof. of Civ. Eng. and Acting Dean, Coll. of Eng., Univ. of Nevada, 737 Evans Ave., Reno, Nev		Sept. 10, 1918
Clark, Arthur Edward. Asst. Div. Engr., Public Service Comm., First Dist., Tremont and Arthur Aves., New York City	Assoc. M. M.	Oct 4, 1910 Sept. 10, 1918
Currie, Clare Harmon. Drainage and Municipal Engr., Webster City, Iowa	Assoc. M. M.	April 1, 1914 Oct. 8, 1918
Davis, John Wolfersperger. Vice-Pres. and Plant Mgr., The Joliet Bridge & Iron Co., Joliet, Ill		Oct. 8, 1918
Duck, Allen Douglas. Cons. Engr., Box 336 Rusk, Tex	Assoc. M. M.	Sept. 12, 1916 Oct. 8, 1918
Enderlein, Max William. Irrig. and Civ. Engr., 121 East Ivy St., Hanford, Cal		Oct. 8, 1918
Hatton, Herbert Watson. Cons. Engr., 2406 Washington St., Wilmington, Del	Jun. Assoc. M. M.	April 4, 1905 June 1, 1909 Oct. 8, 1918
Henderson, Charles Elliott. Asst. Engr., Bureau of Industrial Housing and Transportation, P. O. Box 1903, Washington, D. C		Oct. 8, 1918
Inskeep, Clair Allen. Director of Public Works, and City Engr., Bellefontaine, Ohio		Sept. 10, 1918
Joslin, Harold Vincent. 207 Park Drive, Raleigh, N. C	Jun. Assoc. M. M.	April 6, 1909 Feb. 6, 1912 Oct. 8, 1918
Lyon, Frederic William. Div. Supt., Bureau of Water, Dept. of Public Works, 312 City County Bldg., Pittsburgh, Pa.	Jun. Assoc. M. M.	Oct. 3, 1911 Dec. 31, 1913 Oct. 8, 1918
Mahoney, Joseph Nathaniel. 615 Seventy-seventh St., Brooklyn, N. Y		Oct. 8, 1918
Moses, Howard Eugene. Prin. Asst. Engr., Pennsylvania Dept. of Health, 717 North 2d St., Harrisburg, Pa.		April 16, 1918
Muller, Guttorm. Office Engr., U. S. Realty & Impvt. Co., 1269 Seventy-eighth St., Brooklyn, N. Y		Oct. 8, 1918
Munoz, Gonzalo Claudio. Maj., Ord., U. S. A., Supply Div., 6th and B Sts., N. W., Washington, D. C	Assoc. M. M.	June 24, 1914 Sept. 10, 1918

MEMBERS (*Continued*)

		Date of Membership.
PALMER, WALLACE CROMWELL ALLEN. Capt., Engrs., U. S. A., Co. 5, E. O. T. S., Camp Humphreys, Va. (Res., 311 East Henley St., Olean, N. Y.)	Assoc. M. M.	May 7, 1913 Sept. 10, 1918
PARRIGIN, FRANK SNOW. Chf. Engr., Road and Bridge Constr. for Bay County, P. O. Box 526, Panama City, Fla.	Jun. Assoc. M. M.	May 3, 1910 Oct. 31, 1911 Oct. 8, 1918
PEARSON, ROBERT LOGAN. Div. Engr., N. Y., N. H. & H. R. R., Danbury, Conn.		April 16, 1918
RANDLETT, FRED MORSE. Chf. Engr., Water Dept., City Hall, Portland, Ore.	Assoc. M. M.	Oct. 31, 1911 Oct. 8, 1918
SKINNER, THEODORE HOBART. Supt. of Constr. and Asst. to Res. Mgr., Nitrate Plant No. 2, Muscle Shoals, Ala.		Sept. 10, 1918
SMITH, VERNON HAYES. Contr. Engr., Virginia Bridge & Iron Co., Box 956, Dallas, Tex.		Oct. 8, 1918
STEWARD, HARRY MATTHEW. Chf. Engr., Dept., M. of W., Boston Elev. Ry., 101 Milk St., Boston, Mass.		Sept. 10, 1918
TREES, MERLE J. Vice-Pres. and Mgr., The Chicago Bridge & Iron Co., 9921 South Winchester Ave., Chicago, Ill.		Oct. 8, 1918
WILLIAMS, CLEMENT CLARENCE. Prof. of Ry. Eng., Univ. of Kansas, Lawrence, Kans.	Jun. Assoc. M. M.	June 1, 1909 Oct. 1, 1912 Oct. 8, 1918
WRIGHT, EDWARD. Capt., San C., U. S. A., Co. 44, Bn. 11, Camp Greenleaf, Fort Oglethorpe, Ga.; Address, 505 Washington St., Dedham, Mass.	M.	Oct. 8, 1918
YATES, JOSEPH JOHNSON. Bridge Engr., C. R. R. of N. J., 143 Liberty St., New York City	Assoc. M. M.	May 2, 1906 Oct. 8, 1918

ASSOCIATE MEMBERS

ARNTSON, JULIAN ARTHUR. Field Engr. and Asst. to Supt. of Constr., Am. Smelting & Refining Co., 256 State St., Perth Amboy, N. J.	Oct. 8, 1918
BACHARACH, ERIC WILLIAM. Res. Engr. and Western Mgr., Pittsburgh Filter Mfg. Co., 429 Rialto Bldg., Kansas City, Mo.	Oct. 8, 1918
BEALE, ALLAN SOUTHER. Lieut., U. S. Air Service (Aeronautics), Payne Field, West Point, Miss.; Address, Care, Edgar S. Beale, 253 Pleasant St., Stoughton, Mass.	April 16, 1918
BELMONT, FRANKLYN EDWARD. Structural Steel Draftsman, Office of Borough President, Bronx, 718 West 178th St., New York City	Oct. 8, 1918

ASSOCIATE MEMBERS (*Continued*)

		Date of Membership.
Brier, Burgess Buell. Office Engr., Morgan Eng. Co., 622 Goodwyn Inst., Memphis, Tenn		Oct. 8, 1918
Carr, George Wallis, Jr. Co. F, Prov. Regt., 156th Depot Brigade, Camp Sevier, S. C.; Address, Care, J. W. Carr, 1537 S. Boulevard, Charlotte, N. C		Sept. 10, 1918
Deets, Edward Henderson. Capt., Q. M. C., U. S. A.; Const. Q. M., Fort H. G. Wright, N. Y.; Address, Clarkesburg, Md		Oct. 8, 1918
de Jongh, Juan Isidore. Guatemala, Guatemala		Sept. 10, 1918
Drury, Walter Rhodes. 218 Harrison St., Harriman, Pa	Jun. Assoc. M.	Dec. 31, 1913 Oct. 8, 1918
Edmonston, Arthur Donald. 2d. Lieut., Engrs., U. S. A., Camp Leach, Washington, D. C		Sept. 10, 1918
Emigh, William Chester. Prin. Asst. Engr., Henry W. Taylor, 100 State St., Albany, N. Y		Oct. 8, 1918
Fisher, George Joseph. Lieut., Engrs., U. S. A., Co. E, 219th Engrs., Camp A. A. Humphreys, Va	Jun. Assoc. M.	Dec. 3, 1912 Oct. 8, 1918
Fountain, John Berchman. Draftsman and Engr., Div. of Waterways, Dept. of Public Works and Bldgs., 25 Jackson Boulevard, Room 1404, Chicago, Ill		Oct. 8, 1918
Fowler, John Clair. Prin. Asst. Engr., City of Spokane, 1604 West Mission Ave., Spokane, Wash		May 13, 1918
Gallup, Ralph Forney. County Engr., Marshall County, 610 North 13th, Marysville, Kans		Oct. 8, 1918
Gillean, Charles Henry Howard. Insp. and Junior Engr., Fourth Mississippi River Dist., Care U. S. S. *Natchez*, Natchez, Miss		Oct. 8, 1918
Hazen, Ralph William. 1044 De Kalb St., Norristown, Pa	Jun. Assoc. M.	Nov. 30, 1909 May 13, 1918
Holmes, Thomas Hughes. Capt., Engrs., U. S. A., 311th Engrs., Am. Exp. Forces, France	Jun. Assoc. M.	Jan. 4, 1910 April 16, 1918
Illingworth, George Corliss. Dist. Sales Mgr., Southern Branch, Murphy Iron Works, 1232 Union Trust Bldg., Cincinnati, Ohio	Jun. Assoc. M.	Jan. 2, 1912 Oct. 8, 1918
Keith, Donald Roscoe. Res. Engr., R. Winthrop Pratt, 712 North Jameson Ave., Lima, Ohio		Oct. 8, 1918
Kircher, Paul. Chf. Engr., C. F. Massey Co., 2746 Magnolia Ave., Chicago, Ill		Oct. 8, 1918
Logan, James Bailey. North East, Md		Oct. 8, 1918
Lowden, Spencer William. Res. Engr., California Highway Comm., Bayles, Cal		Oct. 8, 1918

ASSOCIATE MEMBERS (*Continued*)

		Date of Membership.
McCullough, Francis Michael. Prof. of Civ. Eng., and Head, Dept. of Civ. Eng., Carnegie Inst. of Technology, 216 Hastings St., Pittsburgh, Pa		Oct. 8, 1918
Moore, James Archibald. Capt., Engrs., U. S. A., Headquarters 2d Bn., 110th Engrs., Am. Exp. Forces, France; Address, 429 C Ave., Lawton, Okla		April 16, 1918
Nichols, Robert Bradley. Asst. Project Mgr., Hospital Section, Bureau of Yards and Docks, Navy Dept., University Club, Washington, D. C.		April 16, 1918
O'Donnell, John Robert. Res. Production Engr., U. S. Nitrate Plant No. 4, 307 East 4th St., Apartment No. 5, Cincinnati, Ohio	Jun. Assoc. M.	May 31, 1916 Sept. 10, 1918
Olson, John Nathaniel. Office Engr., Valuation Dept., G. C. & S. F. Ry., 1609 Ave. L, Galveston, Tex	Jun. Assoc. M.	Nov. 12, 1913 Sept. 10, 1918
Reynolds, Leo Francis. 2d Lieut., A. S. (A.), U. S. A., 3d Squadron, Ellington Field, Tex.; Address, 103 Clinton Pl., Kansas, City, Mo	Jun. Assoc. M.	June 11, 1917 Sept. 10, 1918
Rice, James Horner. 902 Marshall St., Little Rock, Ark.		Oct. 8, 1918
Sawyer, Charles Legler. 1st Lieut., Engrs., U. S. A., Co. 1, E. O. T. S., Camp Humphreys, Va.; Address, 830 Broadway, Toledo, Ohio		Oct. 8, 1918
Shreve, Ralph Febrey. Engr., Power and Constr. Dept., Ford Motor Co., 294 Tuxedo Ave., Detroit, Mich		Oct. 8, 1918
Sinnock, Pomeroy. In Chg., Purchasing Dept., Grant Smith-Porter Ship Co., Portland, Ore		Oct. 8, 1918
Squire, Edward Jacob. Instr. in Civ. Eng., Polytechnic Inst. of Brooklyn, 33 Argyle Rd., Brooklyn, N. Y.		Oct. 8, 1918
Sweetland, Harold Anthony. Care, Mr. Gibson, Gloucester Apartments, Gloucester St., Brunswick, Ga	Jun. Assoc. M.	Oct. 5, 1909 Oct. 8, 1918
Thatcher, Williams Nelms. County Engr., Harris County, 223 Fourth St., San Antonio, Tex		Oct. 8, 1918
Vollmar, Joseph Edward. Contrs.' Engr. and Supt., 5650 Maple Ave., St. Louis, Mo		Oct. 8, 1918
Wells, Emery. 1st Lieut., Engrs., U. S. A., A. P. O. 712, Am. Exp. Forces, France; Address, Georgetown, Ky.		Oct. 8, 1918
Wilbur, William Edward. Res. Engr., Klyce & Kackley, 1207 Ave. L, Miami, Fla		Oct. 8, 1918
Wyatt, Kirby Kennedy. Estimating Engr., Sinclair Refining Co., 738 North Harvey Ave., Oak Park, Ill.		Oct. 8, 1918
Young, Erving Mandeville. Asst. Engr., Picric Acid Plant, Brunswick, Ga		Oct. 8, 1918

ASSOCIATES

	Date of Membership.
BARRY, EDMUND JOSEPH. Maj., Engrs., U. S. A.; Const. Q. M., Tullytown Bag Loading Plant, Tullytown, Pa.	Oct. 8, 1918
CASE, PAUL DE FORREST. Secy. and Director, Raymond Concrete Pile Co., Ambursen Hydr. Constr. Co. of Canada, and Raymond Concrete Pile Co., Ltd., of Canada, 140 Cedar St., Room 1308, New York City	Oct. 8, 1918

JUNIORS

FIELD, WILLIAM THAYER. Asst. Engr. and Purchasing Agt., U. S. N., Pelham Camp Constr., 976 Broad St., Newark, N. J.	Oct. 8, 1918
KOESTER, EDWIN FERDINAND. Asst. Engr., Street and Sewer Dept., City of Wilmington, 414 West 22d St., Wilmington, Del.	Oct. 8, 1918
LANE, ALBERT LOSSEN. Capt., U. S. A., 50th Inf., Headquarters, Students Army Training Corps, Iowa State Agricultural and Mech. Coll., Ames, Iowa	April 16, 1918
LYON, GEORGE EDMUND. Schaghticoke, N. Y.	Oct. 8, 1918
MALONE, GEORGE WILSON. Lieut., U. S. A., 145th F. A., Am. Exp. Forces, France	Sept. 10, 1918
RICHARD, CHARLES BAILEY. Draftsman, Bridge Dept., Erie R. R., Central Branch Y. M. C. A., 55 Hanson Pl., Brooklyn, N. Y.	Oct. 8, 1918
ROBERTS, CURLIS. Insp., Constr. Dept., N. & W. Ry., 150 Union St., Bluefield, W. Va.	Oct. 8, 1918
TRESER, ALBERT PAUL. 605th Engrs., Am. Exp. Forces, France; Address, 223 Laurel Ave., New Castle, Pa.	Oct. 8, 1918

CHANGES OF ADDRESS

MEMBERS

ALBERTSON, CHARLES. Mgr., Grant Smith-Porter Ship Co., Aberdeen, Wash.

ALLEN, WILLIAM BULLARD. Mgr., Chickasaw Land Co., Chickasaw, Ala.

ANDREWS, HORACE. Cocoanut Grove, Fla.

ANDREWS, JAMES HENRY MILLAR. Lt.-Col., Ord., U. S. A., Commanding Raritan Arsenal, Metuchen, N. J.

ARNOLD, BION JOSEPH. Lt.-Col., Air Service, U. S. A., Army and Navy Club, Washington, D. C.; Address, 105 South La Salle St., Chicago, Ill.

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BLODGETT, JOHN. 25 East 30th St., New York City.

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MEMBERS (*Continued*)

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BURROWES, HARRY GILBERT. Lieut., Engrs. U. S. A., Co. B, 25th Engrs., Am. Exp. Forces, France.

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CHURCHILL, CHARLES SAMUEL. Vice-Pres., N. & W. Ry., Roanoke, Va.

COOK, PAUL DARWIN. Maj., Engr., U. S. A., Commanding 1st Det. Bn., 75th Engrs., Fort Benjamin Harrison, Ind. (Res., 2101 Douglas St., Sioux City, Iowa).

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DOYLE, JOHN STEPHEN. Maj., Engrs., U. S. A.; Special Disbursing Agt., Engr. Dept., U. S. A. (Res., 2451 Maryland Ave.), Baltimore, Md.

DRUMMOND, WILLIAM WORRELL. Capt., Engrs., U. S. A., Co. B, 524th Engrs., A. P. O. 747, Am. Exp. Forces, France (Res. 447 Broadway, Winter Hill, Mass.).

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ERNST, OSWALD HERBERT. Maj.-Gen., U. S. A. (*Retired*), 1321 Connecticut Ave., Washington, D. C.

FINLEY, EDWIN CLIFFORD. Constr. Div., War Dept., 7th and B Sts., Washington, D. C.

FORTIN, SIFROY JOSEPH. Deputy Director of Public Works; Deputy Chf. Engr., City of Montreal, City Hall, Montreal, Que., Canada.

GARRETT, JAMES EDWIN. Paragould, Ark.

GILLESPIE, RICHARD HENWOOD. Care, Graham, Anderson, Probst & White, Designing Engrs., U. S. Govt. Explosives Plant "C", Nitro, W. Va. (Res., 343 East 195th St., New York City).

GLAZIER, WILLIAM LEONARD. Maj., Engrs., U. S. A.; Commanding Officer, 525th Engrs., Service Bn., Am. Exp. Forces, France; City Engr., Fort Thomas and Marysville; Cons. Engr., York St. and Court Pl., Newport, Ky.

GOETHALS, GEORGE WASHINGTON. Maj.-Gen., U. S. A.; Asst. Chf. of Staff, Div. of Purchase, Storage and Traffic, Washington, D. C.

GOW, CHARLES RICE. Maj., Q. M. C., U. S. A.; Const. Q. M., Boston Army Supply Base, Boston, Mass.; Civ. Engr. and Contr. (Charles R. Gow & Co.), West Roxbury, Mass.

GOWDY, ROY COTSWORTH. Chf. Engr., Colo. & South. Ry., Room 219, Railway Exchange Bldg., Denver, Colo.

MEMBERS (*Continued*)

Grant, John Robert. Maj., M. C., R. E., Offizier-Gefangenenlager, Stralsund (Danholm), Germany.

Grant, Kenneth Crothers. Maj., Q. M. C., U. S. A.; Officer in Chg. of Constr., Camp Grant, Rockford, Ill.

Graves, Walter Hayden. Civ., Hydr. and Cons. Engr., San Francisco, Cal.

Greenfield, Robert Arthur. Maj., Engrs., U. S. A., Camp Humphreys, Va.

Gregory, John Herbert. Capt., San. C., U. S. A.; Res., 53 Christopher St., Montclair, N. J.

Gross, Daniel Wingerd. Corporation Engr., A. C. L. R. R., Wilmington, N. C.

Gutman, David. Maj., Engrs., U. S. A., 5th Prov. Bn., Fort Benjamin Harrison, Ind.

Hallihan, John Philip. Maj., Engrs., U. S. A., Fort Douglas, Utah; Address, 143 West 92d St., New York City.

Hammond, John Farnsworth. Cons. Engr., N. E. Corner, Sagemore and Woodhull Aves., Hollis, N. Y.

Harrington, Ferdinand Finney. Care, Div. of Capital Expenditures, Interstate Commerce Bldg., Washington, D. C.

Hewes, Virgil Henry. Stratfield Hotel, Bridgeport, Conn.

Hoad, William Christian. Lt.-Col., San. C., U. S. A., Surgeon-General's Office, U. S. A., Washington, D. C.

Hodge, Henry Wilson. Col., U. S. A.; Asst. Chf. Engr., Am. Exp. Forces, G. H. Q., Am. Exp. Forces, France.

Hoover, Andrew Pearson. Maj., Q. M. C., U. S. A.; Const. Q. M., New Orleans Army Supply Base, New Orleans, La.; Cons. Engr. (Goodrich, Hoover & Bennett), 261 Broadway, New York City.

Howe, Herbert Frank. Capt., Engrs., U. S. A.; Student Co. 4, E. O. T. S., Camp Humphreys, Va. (Res., 12 Chester Rd., Belmont, Mass.).

Hubbard, Frank Richards. 670 Forty-fourth St., Des Moines, Iowa.

Hunt, William Henry. New York Mgr., Pittsburgh Bridge & Iron Works, 52 Broadway, New York City.

Jackson, Edward Sherman. Engr.'s Office, G. N. Ry., Great Falls, Mont.

Johnson, Granville. (Monks & Johnson), 99 Chauncy St., Boston, Mass.

Jonah, Frank Gilbert. Lt.-Col., Engrs., U. S. A.; Chf. Engr., Div. of Light Rys. and Roads, U. S. A. P. O. No. 706, Am. Exp. Forces, France.

Judson, William Voorhees. Brig.-Gen., U. S. A., Headquarters, Port of Embarkation, Pier 2, Hoboken, N. J.

Kendall, Charles Hanford. U. S. Senior Highway Engr., 501 Wheat Bldg., Fort Worth, Tex.

Kielland, Soren Theodor Munch Bull. Engr., Buffalo Creek R. R.; Vice-Consul of Norway, 202 Lehigh Terminal Bldg., Buffalo, N. Y.

Kirkbride, Walter Harold. Chf. Engr., S. P. R. R., U. S. R. R. Administration, San Francisco, Cal.

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REINSTATEMENTS

MEMBERS	Date of Reinstatement
Clark, Roscoe Nathaniel	Oct. 8, 1918

RESIGNATIONS

MEMBERS	Date of Resignation.
Baxter, Frank Edwin	Oct. 8, 1918

ASSOCIATES	
Bruce, John Moffatt	Oct. 8, 1918

DEATHS

Africa, James Murray. Elected Member, September 2d, 1896; died September 18th, 1918.

Bryson, Andrew. Elected Member, April 1st, 1885; died October 1st, 1918.

Decker, John Hull. Elected Junior, September 6th, 1904; Associate Member, December 5th, 1906; died, October 10th, 1918.

Harlow, James Hayward. Elected Member, March 4th, 1874; died October 6th, 1918.

Jacobs, Julius Lilien. Elected Junior, September 1st, 1908; Associate Member, February 28th, 1911; Member, March 2d, 1915; died October 2d, 1918.

Menke, William. Elected Junior, December 6th, 1910; Associate Member, April 16th, 1918; died November 1st, 1918.

Merrill, Ogden. Elected Associate Member, February 3d, 1904; died October 5th, 1918.

Murray, James Powell. Elected Associate Member, November 28th, 1916; died September 28th, 1918.

O'Brien, William Arthur. Elected Associate Member, January 2d, 1912; died October 12th, 1918.

Palmer, Richard Jeter, Jr. Elected Junior, October 10th, 1916; died October 13th, 1918.

Rannells, Clarence J. Elected Associate Member, October 3d, 1906; date of death unknown.

Sleppy, Kirby Baldwin. Elected Junior, December 3d, 1912; killed in action (France); date of death unknown.

Weekes, Clifton L'Orignal. Elected Junior, October 9th, 1917; died October 8th, 1918.

Weeks, Harry Arthur. Elected Associate Member, April 4th, 1911; died September 22d, 1918.

Total Membership of the Society, November 7th, 1918, 8 917.

MONTHLY LIST OF RECENT ENGINEERING ARTICLES OF INTEREST

(September 23d to October 31st, 1918)

NOTE.—*This list is published for the purpose of placing before the members of this Society, the titles of current engineering articles, which can be referred to in any available engineering library, or can be procured by addressing the publication directly, the address and price being given wherever possible.*

LIST OF PUBLICATIONS

In the subjoined list of articles, references are given by the number prefixed to each journal in this list:

(2) *Journal,* Engrs. Club of Phila., Philadelphia, Pa.
(3) *Journal,* Franklin Inst., Philadelphia, Pa., 50c.
(4) *Journal,* Western Soc. of Engrs., Chicago, Ill., 50c.
(5) *Journal,* Eng. Inst. of Canada, Montreal, Que., Canada.
(6) *Journal,* Am. Inst. of Archts., Washington, D. C., 50c.
(8) *Stevens Indicator,* Hoboken, N. J., 50c.
(9) *Industrial Management,* New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, 432 Fourth Ave., New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News-Record,* New York City, 15c.
(15) *Railway Age,* New York City, 15c.
(16) *Engineering and Mining Journal,* New York City, 15c.
(17) *Electric Railway Journal,* New York City, 10c.
(18) *Railway Review,* Chicago, Ill., 15c.
(19) *Scientific American Supplement,* New York City, 10c.
(20) *Iron Age,* New York City, 20c.
(21) *Railway Engineer,* London, England, 1s. 2d.
(22) *Iron and Coal Trades Review,* London, England, 6d.
(24) *American Gas Engineering Journal,* New York City, 10c.
(25) *Railway Mechanical Engineer,* New York City, 20c.
(26) *Electrical Review,* London, England, 4d.
(27) *Electrical World,* New York City, 10c.
(28) *Journal,* New England Water-Works Assoc., Boston, Mass., $1.
(29) *Journal,* Royal Society of Arts, London, England, 6d.
(32) *Mémoires et Compte Rendu des Travaux,* Soc. Ing. Civ. de France, Paris, France.
(33) *Le Génie Civil,* Paris, France, 1 fr.
(36) *Cornell Civil Engineer,* Ithaca, N. Y.
(42) *Proceedings,* Am. Inst. Elec. Engrs., New York City, $1.
(43) *Annales des Ponts et Chaussées,* Paris, France.
(45) *Coal Age,* New York City, 10c.
(46) *Scientific American,* New York City, 15c.
(47) *Mechanical Engineer,* Manchester, England, 3d.
(54) *Transactions,* Am. Soc. C. E., New York City, $12.
(55) *Journal,* Am. Soc. M. E., New York City, $10.
(56) *Transactions,* Am. Inst. Min. Engrs., New York City, $6.
(57) *Colliery Guardian,* London, England, 5d.
(58) *Proceedings,* Engrs.' Soc. W. Pa., 2511 Oliver Bldg., Pittsburgh, Pa., 50c.
(59) *Proceedings,* American Water-Works Assoc., Troy, N. Y.
(60) *Municipal and County Engineering,* Indianapolis, Ind., 25c.
(61) *Proceedings,* Western Railway Club, 225 Dearborn St., Chicago, Ill., 25c.
(62) *American Drop Forger,* Thaw Bldg., Pittsburgh, Pa., 10c.
(63) *Minutes of Proceedings,* Inst. C. E., London, England.
(64) *Power,* New York City, 5c.
(65) *Official Proceedings,* New York Railroad Club, Brooklyn, N. Y., 15c.
(66) *Gas Journal,* London, England, 6d.
(67) *Cement and Engineering News,* Chicago, Ill., 25c.
(71) *Journal,* Iron and Steel Inst., London, England.
(71*a*) *Carnegie Scholarship Memoirs,* Iron and Steel Inst., London, England.
(72) *American Machinist,* New York City, 15c.
(73) *Electrician,* London, England, 18c.
(74) *Transactions,* Inst. of Min. and Metal., London, England.
(75) *Proceedings,* Inst. of Mech. Engrs., London, England.
(77) *Journal,* Inst. Elec. Engrs., London, England, 5s.
(83) *Gas Age,* New York City, 15c.
(85) *Proceedings,* Am. Ry. Eng. Assoc., Chicago, Ill.
(86) *Engineering and Contracting,* Chicago, Ill., 10c.
(87) *Railway Maintenance Engineer,* Chicago, Ill., 10c.
(89) *Proceedings,* Am. Soc. for Testing Materials, Philadelphia, Pa., $5.

(90) *Transactions,* Inst. of Naval Archts., London, England.
(91) *Transactions,* Soc. of Naval Archts. and Marine Engrs., New York City.
(92) *Bulletin,* Soc. d'Encouragement pour l'Industrie Nationale, Paris, France.
(93) *Revue de Métallurgie,* Paris, France, 4 fr. 50.
(96) *Canadian Engineer,* Toronto, Ont., Canada, 10c.
(98) *Journal,* Engrs. Soc. Pa., Harrisburg, Pa., 30c.
(99) *Proceedings,* Am. Soc. of Municipal Improvements, New York City, $2.
(100) *Professional Memoirs,* Corps of Engrs., U. S. A., Washington, D. C., 50c.
(101) *Metal Worker,* New York City, 10c.
(103) *Mining and Scientific Press,* San Francisco, Cal., 10c.
(104) *The Surveyor and Municipal and County Engineer,* London, England, 6d.
(105) *Chemical and Metallurgical Engineering,* New York City, 25c.
(106) *Transactions,* Inst. of Min. Engrs., London, England, 6s.
(107) *Schweizerische Bauzeitung,* Zürich, Switzerland.
(109) *Journal,* Boston Soc. C. E., Boston, Mass., 50c.
(110) *Journal,* Am. Concrete Inst., Philadelphia, Pa., 50c.
(111) *Journal of Electricity,* San Francisco, Cal., 25c.
(113) *Proceedings,* Am. Wood Preservers' Assoc., Baltimore, Md.
(114) *Journal,* Institution of Municipal and County Engineers, London, England, 1s. 6d.
(115) *Journal,* Engrs.' Club of St. Louis, St. Louis, Mo., 35c.
(116) *Blast Furnace and Steel Plant,* Pittsburgh, Pa., 15c.
(117) *Engineering and Cement World,* Chicago, Ill.
(118) *Times Engineering Supplement,* London, England, 2d.
(119) *Landscape Architecture,* Harrisburg, Pa., 50c.
(120) *Automotive Industries,* New York City, 15c.

LIST OF ARTICLES

Bridges.

The New Quebec Bridge.* **(11)** Sept. 13.
A Pontoon Drawbridge that Operates on "River Kite" Principle.* Halbert P. Gillette. **(86)** Sept. 25.
Architecture and Construction of Bridges. Charles Evan Fowler. **(65)** Oct.
Recommended Practice in Design and Construction of Permanent Highway Bridges of Concrete and Steel. John W. Towle. **(60)** Oct.
Low-Water Highway Bridges in Oklahoma.* J. W. Evans. **(60)** Oct.
Bridge Construction Plant—Features of Arch Bridge, Des Moines, Ia.* Albert M. Wolf. **(117)** Oct. 1.
Method of Numbering County Bridges and Making Bridge and Drainage Map.* J. C. McLean. (From *Service Bulletin* of Iowa Highway Comm.) **(96)** Oct. 17.
Bridge Construction with Timber, Concrete and Stone Under Present War Conditions. O. L. Grover. (From article in *Public Roads.*) **(86)** Oct. 23.
Note sur la Quadrature d'Aires Limitées par des Arcs de Parabole et Correction de la Formule de Poncelet.* Goupil. **(43)** May.
Calcul des Arcs Encastrées, Sollicités par des Charges Extérieures Continues.* Ernest Flamand. **(33)** Sept. 14.
Zum Wettbewerb für eine Strassenbrücke uber die Reuss bei Gisikon.* **(107)** Sept. 14.
Die Berechnung des durchlaufenden Brückengewölbes auf elastischen Pfeilern.* A. Strassner. **(107)** Sept. 21.
Zwillingsbogen-Brücke über die Rhone in Lyon.* **(107)** Oct. 5.

Electrical.

The Capacity-Potential Curves of an Induction Coil. E. Taylor Jones. **(73)** Aug. 30.
The Cumberland Electrolytic System for the Prevention of Scale and Corrosion.* **(73)** Sept. 13.
The Calculation of Single-Phase and Three-Phase Lines.* J. R. Dick. (From *Electric Mains and Distributing Systems.*) **(73)** Sept. 20.
Earthing Power-Station Equipment.* P. H. Adams. **(64)** Sept. 24.
The Electricity Supply of Archangel.* **(26)** Sept. 27.
The Remote Control of Motor-Driven Pumps and Compressors.* F. M. Nourse. **(60)** Oct.
Cedar Rapids Big Steam Plant.* **(64)** Oct. 1.
The Running and Maintenance of Induction Motors at Collieries.* L. Fokes. **(57)** Serial beginning Oct. 4.
Load Division Between Synchronous Frequency Changers Operating in Parallel. Quentin Graham. **(64)** Serial beginning Oct. 8.
Magnetism in Magneto-Generators. Harry F. Geist. **(119)** Oct. 10.
The Operation of Rotary Converters. J. Humphrey. **(22)** Oct. 11.
New Wood-Burning Station of Northwestern Electric Company.* W. A. Scott. **(117)** Oct. 15.

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Electrical—(Continued).

Excellent Results with Pulverized Coal at Milwaukee.* (64) Oct. 15.
Electric Dynamometers for Aircraft Engine Tests.* (120) Oct. 17.
Airplane Motor-Ignition Systems.* B. Z. Reiter. (72) Oct. 17.
Fundamental Relations Between Direct- and Alternating-Current Circuits.* Terrell Croft. (45) Oct. 24.
La Nouvelle Usine Electrique de la Compañia Italo-Argentina de Electricidad à Buenos Aires.* P. Calfas. (33) Mar. 16.

Marine.

The Most Suitable Sizes and Speeds for General Cargo Steamers.* John Anderson. (90) Vol. 60, 1918.
Standard Cargo Ships.* George Carter. (90) Vol. 60, 1918.
Problems of the Future in the Design and Construction of Merchant Ships. W. S. Abell. (90) Vol. 60, 1918.
The Effect of the Longitudinal Motion of a Ship on Its Statical Transverse Stability.* G. S. Baker and E. M. Keary. (90) Vol. 60, 1918.
A Preliminary Survey of the Possibilities of Reinforced Concrete as a Material for Ship Construction.* Maurice Denny. (90) Vol. 60, 1918.
Reinforced Concrete Vessels.* Walter Pollock. (90) Vol. 60, 1918.
On the Design and Construction of Self-Propelled Reinforced Concrete Sea-Going Cargo Steamers, now Building in Great Britain.* T. G. Owens Thurston. (90) Vol. 60. 1918.
An Investigation of the Shearing Force and Bending Moment Acting on the Structure of a Ship, Including Dynamic Effects.* A. M. Robb. (90) Vol. 60, 1918.
The Air Supply to Boiler Rooms.* Richard W. Allen. (90) Vol. 60, 1918.
The Application of Electric Welding to Ship Construction and Repair. (73) Aug. 30.
The Yarrow Anti-Submarine Smoke System.* (12) Sept. 13.
The Cumberland Electrolytic System for the Prevention of Scale and Corrosion.* (73) Sept. 13.
Reinforced Concrete 3 500-Ton Deadweight U. S. Ship.* R. J. Wigg. (From Report to Shipping Board.) (11) Sept. 20.
Hog Island, an American Achievement.* (62) Oct.
Concrete Coal Barges.* J. F. Springer. (45) Oct. 3.
Great Submarine-Chaser Factory Produces "Eagles" by Indoor Shipbuilding System.* (13) Oct. 17.
Building Wooden Ships for the Emergency Fleet Corporation.* E. A. Suverkrop. (72) Oct. 17.
Salvaging the Steamship *St. Paul*.* (46) Oct. 19.
Method of Building Concrete Barges at Yard of Aberthaw Construction Co. (86) Oct. 23.
Thirteen-Thousand Ton Vessel Righted by Rolling and Lifting.* (13) Oct. 24.
Shipbuilding Methods of the "Eagle" Chaser Factory.* (13) Oct. 31.
Les Appareils de Levage dans les Chantiers de Constructions Navales. (33) Sept. 21.
Le Sauvetage des Navires Coulés.* A. Poidloué. (33) Sept. 28.

Mechanical.

A Cause of Failure in Boiler Plates.* Walter Rosenhain and D. Hanson. (71) Vol. 97, 1918.
Traction on Bad Roads or Land.* L. A. Legros. (75) Jan.
The Employment of Women in Munition Factories. O. E. Monkhouse. (75) Mar.
The Efficient Utilization of Labour in Engineering Factories. Ben H. Morgan. (75) May.
Efficiency of the Screw.* Benjamin F. Groat. (58) June.
Development of Gun Manufacture.* W. H. W. Skerrett. (100) Sept.
Clinker and Ash in Fuel. (118) Sept.
Silica Refractory Bricks. (66) Sept. 3.
Pumping Engines for Cairo Main Drainage. (11) Sept. 6.
The Hannoveraner Biplane.* (12) Sept. 13.
The Utilisation of Waste Heat from Open-Hearth Furnaces for the Generation of Steam. Thomas B. Mackenzie. (22) Sept. 13.
The Rumpler Two-Seater Biplane.* (13) Sept. 20.
Portable Automatic Trimming Conveyor.* (57) Sept. 20.
Steam-Boiler Regulation and Control.* Albert A. Straub. (64) Sept. 24.
The Distillation of Coal in a Vacuum. Amé Pictet. (Translation from *Revue Generale des Sciences.*) (105) Sept. 25.
Potash as a By-Product.* J. S. Grasty. (105) Sept. 26.
A Wet Process for Extracting Potash from Cement Dust.* J. G. Dean. (105) Sept. 26.

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* Illustrated.

Mechanical—(Continued).

Carborundum Refractories. S. C. Linbarger. (105) Sept. 27.
Carbonisation Reactions. J. W. Cobb. (William Young Memorial Lecture read before North British Assoc. of Gas Mgrs.) (57) Sept. 27.
A Physical Study of the Welsbach Mantle.* Herbert E. Ives and others. (3) Oct.
Are There Advantages in Welding Boiler Plate?* Howard L. Boyd. (From *California Safety News.*) (64) Oct. 1.
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AMERICAN SOCIETY OF CIVIL ENGINEERS
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PAPERS AND DISCUSSIONS

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THE ECONOMICS OF STEEL ARCH BRIDGES

Discussion.*

By Edward W. Stoney, Esq.

Edward W. Stoney,† Esq., (by letter).‡—The writer has read with great interest this most valuable paper, but regrets that he is unable to add usefully to its discussion, as Indian engineers have had no occasion to consider, or opportunities to use, metal arch bridges. Mr. Stoney

The many large and long railway bridges which have been built in India are generally over sand and silt river beds of great depth, and require foundations sunk to from 100 to 150 ft. below these beds; in fact, at the "Lower Ganges" Hardinge Bridge, recently built under the supervision of Sir Robert R. Gales, the foundations are from 180 to 185 ft. below the river bed.

The banks of these rivers, also, are often but little above the river beds, so that arches would be quite unsuitable because as much waterway as possible has to be provided, without unnecessarily raising the approaches.

The writer thinks that the economics and costs of maintaining girder and arch metal bridges of similar span might be given by American engineers who have had to do with both. The maintenance of long-span girder bridges with intricate systems of bracing causes considerable expense, trouble, and anxiety to railway men.

The writer desires to invite the attention of American engineers to a rather remarkable book§ by the late Sir B. Baker, Hon. M. Am.

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* Discussion of the paper by J. A. L. Waddell, M. Am. Soc. C. E., continued from October, 1918, *Proceedings*.

† Coonoor, Madras Presidency, India.

‡ Received by the Secretary, October 17th, 1918.

§ Published by E. F. Spon, London, 1870.

Mr. Stoney.

Soc. C. E., entitled "Beams, Columns, and Arches", in which the author discusses metal arches, gives simple formulas for computing their approximate dimensions, and compares the results obtained thereby with the elaborate calculations made by the late Capt. J. B. Eads, M. Am. Soc. C. E., for the St. Louis steel arch bridge.

The writer would also call attention to the paper* entitled "Curve of Equilibrium for a Rigid Arch under Vertical Forces", by Mr. George Fuller. In this paper Mr. Fuller shows how this curve may be derived graphically, at once, from the bending moment diagram produced by these forces.

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* *Minutes of Proceedings,* Inst. C. E., Vol. XL (1874–75), p. 143.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications.

VERIFICATION OF THE BAZIN WEIR FORMULA BY HYDRO-CHEMICAL GAUGINGS

Discussion.*

By B. F. Groat, M. Am. Soc. C. E.

Mr. Groat.

B. F. Groat,† M. Am. Soc. C. E. (by letter).‡—Mr. Herschel gives some valuable suggestions as to weir coefficients.§ The writer adds that, perhaps, a correct application of the theory of similarity‖ may further simplify the question for geometrically similar weirs with proportional heads, provided the latter are not too small.

It should be observed, however, that to have exact similarity, under given gravitational forces, the model weir should be tested with a different fluid from that discharged by the prototype. As an example, a weir about one-sixth of full size might be tested with mercury at a proper temperature. This calls attention to the fact that temperature observations have been omitted too frequently in the past.

In referring to the dynamic reactions of different fluids, it should be borne in mind that the same fluid under different viscosity conditions (as water at different temperatures) acts exactly as so many different fluids. Weirs under low heads are certainly very sensitive to changes in viscosity and, therefore, to changes of temperature.

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[*] Discussion of the paper by Floyd A. Nagler, Assoc. M. Am. Soc. C. E., continued from August, 1918, *Proceedings*.

[†] Pittsburgh, Pa.

[‡] Received by the Secretary, October 14th, 1918.

[§] *Proceedings*, Am. Soc. C. E., August, 1918, p. 835.

[‖] "Ice Diversion, Hydraulic Models, and Hydraulic Similarity", *Transactions*, Am. Soc. C. E., Vol. LXXXII (1918), p. 1138.

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IMPROVING ARCH ACTION IN ARCH DAMS

Discussion.*

By W. H. R. Nimmo, Assoc. M. Am. Soc. C. E.

W. H. R. Nimmo,† Assoc. M. Am. Soc. C. E. (by letter).‡—The deflection curves presented by the author form a valuable contribution to the available data on arch dams, and it is to be hoped that other engineers having charge of large arch dams will make similar observations. If an analysis is made of the arch and cantilever stresses at different levels in any arched dam, the results will indicate a deflection curve of the same general shape as that of the curves obtained by the author, this being especially true of the movements of the crest. The peculiar bend in the curves at Elevation 1095 is significant, as it indicates the extent to which conditions during construction may influence the subsequent behavior of the dam. Mr. Nimmo.

In his discussion of the late Mr. L. A. B. Wade's paper, "Concrete and Masonry Dam-Construction in New South Wales"§, Mr. De Burgh describes a concrete arch dam, 38 ft. high, built for domestic supply at Barren Jack, and the deflection curves shown in Fig. 10 are reproduced from his discussion. At the right abutment, the stress is distributed into the rock by a concrete abutment and wing-wall, but it is stated that there is no indication of any yield having taken place at this point. The movements of the crest, however, are not such as theory would lead one to expect. The dam was completed in December,

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* Discussion of the paper by L. R. Jorgensen, M. Am. Soc. C. E., continued from August, 1918, *Proceedings*.

† Hobart, Tasmania.

‡ Received by the Secretary, October 14th, 1918.

§ *Minutes of Proceedings*, Inst. C. E., Vol. CLXXVIII.

Mr. Nimmo. 1908, and the first set of measurements, used as a datum in Fig. 10, were taken on December 24th, 1908. If these measurements were taken very soon after placing the last lift of concrete, it is probable that the initial shrinkage of the concrete would unduly influence the movement of the crest relative to the rest of the dam. In Fig. 11 the writer has replotted the curves, using the measurements of December 26th, 1908, as a datum, and it will be seen that the movements of the crest become more logical. The two left-hand curves of Fig. 11 show the influence of a decided rise in temperature on the thin crest (in this case 2 ft. thick). In the two right-hand curves of Fig. 11, the water is practically at the same level in each case, and, although the temperature of the air on May 25th, 1909, was below that of

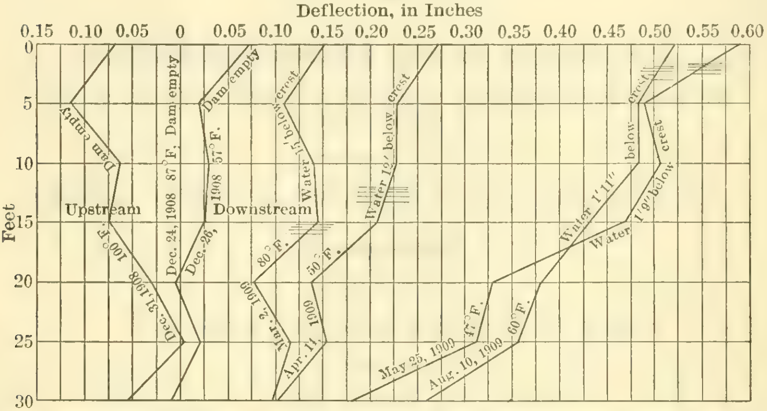

FIG. 10.

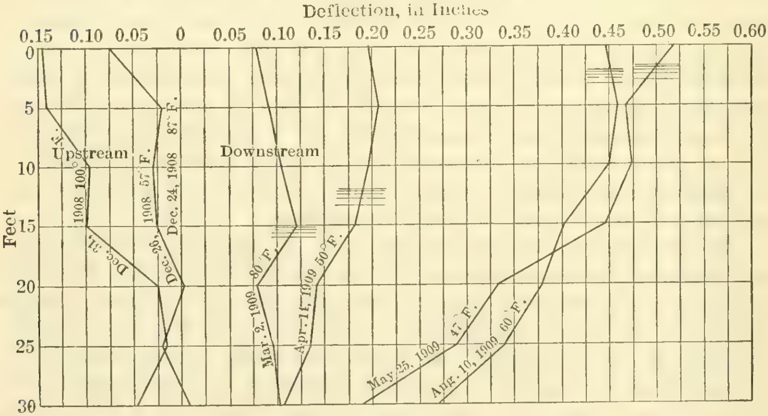

FIG. 11.

Mr. Nimmo.

August 10th, 1909, the actual temperature of the water and of the thicker concrete in the lower levels would probably be higher in May than in August. The thin crest, however, would respond more readily to a fall in temperature, and this appears to be the reason for the two curves crossing each other. It is of interest to notice that the curves at a point 20 ft. below the crest show a bend somewhat similar to that shown by the author's curves at Elevation 1095, but no information is given as to temperatures during construction. This dam contained a considerable percentage of longitudinal and vertical reinforcement in the form of old rails, but its presence does not appear to have had any effect on the general shape of the deflection curves.

MEMOIRS OF DECEASED MEMBERS

NOTE.—Memoirs will be reproduced in the volumes of *Transactions*. Any information which will amplify the records as here printed, or correct any errors, should be forwarded to the Secretary prior to the final publication.

JAMES MURRAY AFRICA, M. Am. Soc. C. E.*

DIED SEPTEMBER 18TH, 1918.

James Murray Africa, son of the late J. Simpson Africa and Dorothea Greenland Africa, was born in Huntingdon, Pa., on April 11th, 1863. His father was a well-known surveyor of Huntingdon, who had served a term as Secretary of Internal Affairs of the State of Pennsylvania.

After completing his studies in the public schools of his native town, Mr. Africa entered Juniata College. He was graduated from Rensselaer Polytechnic Institute with high honors in 1888.

Even before his graduation from Rensselaer, Mr. Africa had been engaged in engineering work, having entered, in 1875, an engineer's office as a student. In 1882, he was appointed a member of a commission to determine the lines of Jackson, Miller, and Barree Townships in Huntingdon County, Pa. In 1882 and 1883, he was in charge of topographical and boundary surveys of the coal and ore lands of R. H. Powell and Company, and of the Huntingdon and Broad Top Mountain Railroad, in Huntingdon and Clearfield Counties, Pa. In 1884, he was elected City Engineer of Huntingdon, Pa., which office he retained for nearly thirty years, during which time he designed and constructed the sewerage system of the town as well as its water-works.

After his graduation, Mr. Africa immediately began to engage actively in his chosen profession as a Civil and Mining Engineer and Geologist. In 1888, he designed water-works systems for Palmyra and Riverton, N. J., and was retained as Consulting Engineer by the Union Trust Company of Philadelphia, Pa., which furnished the funds for the Westmoreland County Water-Works.

In December, 1888, Mr. Africa was appointed Assistant Engineer of the Chautauqua Lake Railroad. He was afterward promoted to be Chief Engineer of that road and, in July, 1889, became also General Manager. From July, 1890, to February, 1891, he was Chief Engineer and General Manager of the Etowah Iron Company, at Cartersville, Ga., for which Company he constructed 12 miles of railroad and designed and erected a mill for the concentration of manganese ore.

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* Memoir prepared by the Secretary from information furnished by C. A. Sundstrom, M. Am. Soc. C. E., and on file at Society Headquarters.

From July to December, 1891, he was in charge of the survey of the lands of the Rockhill Iron and Coal Company, in Huntingdon County, Pa., as well as of the Robert Hare Powell coal operations in Huntingdon, Blair, and Clearfield Counties, Pa.

In 1892 and 1893, Mr. Africa designed and supervised various street improvements in Huntingdon; and, in 1894, he was appointed Chief Engineer of the Pennsylvania Midland Railroad, which position he held for a number of years. Among his later works were the ganister rock developments of the Harbison-Walker Company, the design and construction of the Standard Steel Works plant, at Burnham, Pa., the recent enlargement of the Pennsylvania Railroad Yards at Northumberland, Pa., and the construction of the Blair Memorial Hospital.

Mr. Africa's one hobby was Masonry. He had become affiliated with that Order at an early age, as a member of Mt. Moriah Lodge of Huntingdon, Pa., and had devoted much of his time and interest to its work. He was also a member of Standing Stone Chapter, No. 201, Royal Arch Masons, and of Huntingdon Commandery No. 65, Knights Templar.

In 1908, he was appointed Consulting and Supervising Engineer of the Masonic Homes Properties, at Elizabethtown, Pa. He superintended the construction of the buildings and laid out the grounds of these properties with the greatest interest and care, giving to the work, because of his great love for its object, the best of which he was capable, having declared that "it was one of the dearest creations of his life."

As a Civil and Mining Engineer, Mr. Africa was widely known throughout the State of Pennsylvania. He was frequently called upon as an expert in lawsuits relative to land surveys and as an appraising engineer in disputed valuations and of property acquired under right of eminent domain. His views as a Consulting Engineer were frequently sought and his opinions were held in high esteem from a legal standpoint.

Mr. Africa was prominently identified with the social, political and civic life of his community. He was a member of the Engineers Club of Philadelphia, Pa., a Democrat in politics, and a progressive, public-spirited, and useful citizen. In writing of him at the time of his death, the Hon. George B. Orlady, of Huntingdon, states "in private life, Mr. Africa was one of our most important citizens and his untimely death will be mourned by all who ever came within the zone of his influence." In his religious affiliations, he was a consistent member of the Presbyterian Church, and at the time of his death was serving as a Trustee of that church at Huntingdon.

Mr. Africa had been in declining health for several years, suffering from hardening of the arteries and heart trouble. He had, however, kept up his business and professional interests, and for several days prior to his sudden death on September 18th, 1918, at the University Hospital, Philadelphia, Pa., had been engaged in giving expert testimony in an important lawsuit.

On June 1st, 1890, he was married to Miss Eleanor McKnight, of Reading, Pa., who, with three sons, two of whom are in the military service of the United States, survives him.

Mr. Africa was elected a Member of the American Society of Civil Engineers, on September 6th, 1896.

JOHN HOWE PEYTON, M. Am. Soc. C. E.*

DIED SEPTEMBER 14TH, 1918.

John Howe Peyton was the fourth son of William Preston Peyton, of Montgomery County, Virginia, and Sarah Elizabeth (Mumford) Peyton of Richmond, Va. His paternal grandfather, Major Garnet Peyton, was in active service in the United States Army during the War of 1812. His maternal grandfather was a man of great literary ability, whose chief work was the translation of Homer's Iliad into blank verse. John Howe Peyton was born in Howard County, Missouri, on March 17th, 1864, his parents having thought to make their future home there, but returned to Virginia soon after the close of the Civil War. His family, like many others, suffered many hardships as a result of the war, but his father succeeded in giving each of his five sons a college education. In December, 1873, the family moved to Salem, Va., and he entered the Preparatory Department of Roanoke College, finishing his course in 1881.

At that time railroad construction and surveys were active, and Mr. Peyton joined one of the engineering parties of the Richmond and Louisville Railroad, a project which was being pushed at that time.

In 1883 he was Instrumentman for the Farmville and Powhattan Railroad, and from 1885 to 1888 he was Resident Engineer on construction for the Lynchburg and Durham Railroad, later holding a similar position with the Georgia, Carolina and Northern Railway. From 1889 to 1891 he was Assistant to the Chief Engineer of the Charleston, Clendenning and Sutton Railroad.

From 1892 to 1898 Mr. Peyton engaged in private practice as an Engineer and in contracting, having his office at Charleston, W. Va. In 1899 he joined the United States Army, and became a Sergeant in the Engineer Corps, and, later in the year, went to the Philippines as special representative of the Protestant Episcopal Church.

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* Memoir prepared by Hunter McDonald, Past-President, Am. Soc. C. E.

From 1900 to 1901 he was Resident Engineer of the Chesapeake and Ohio Railroad, and, later, was made Chief Engineer of the Great Eastern Railroad, serving in that capacity until 1902, when he entered the service of the Louisville and Nashville Railroad Company as Locating Engineer. His work for this company consisted of surveys and estimates for extensions, and for reducing grades on their existing lines. He at that time located the revision of the line and grade of the Henderson Division, between Edgefield Junction and Hygeia, where a 4% grade was replaced with a 0.7% grade, requiring very heavy work and a tunnel about 4 000 ft. long. He also located the Atlanta, Knoxville and Northern Railway, from Etowah, Tenn., to a junction with the Western and Atlantic Railroad, at Junta, Ga. He was placed in charge of the construction of these two lines, but was made Principal Locating Engineer for the company in 1904, and served in that capacity until 1907.

After the panic of 1907, Mr. Peyton left the service of the Louisville and Nashville Railroad Company, and accepted a position with the Union Pacific Railroad in the Northwest, making investigations in Montana, Washington, Oregon, and British Columbia. He returned to the service of the Louisville and Nashville Railroad Company in 1910 as Assistant to the President.

In March, 1912, he was made Chief Engineer of Construction, and carried the title of Assistant to the President and Chief Engineer of Construction, Louisville and Nashville Railroad Company. His duties consisted of locating and superintending the construction of a number of very heavy pieces of grade reduction and extension work, notably the Lewisburg and Northern, extending from Portland, Tenn., to Decatur, Ala., the revision of the South and North Alabama Railroad, between Decatur and Birmingham, the Lexington and Eastern Railroad, an extension from Covington, Ky., into the coal fields of Eastern Kentucky, and the Tuscaloosa Mineral Railway.

In January, 1914, Mr. Peyton was appointed General Manager and, in April following, President of the Nashville, Chattanooga and St. Louis Railway Company. He assumed the duties of these offices with preconceived ideas of the obligations of the railroads to the public, and entered at once into a vigorous campaign to put these ideas into effect.

He traveled over the lines of road on trains and in motor cars, studying location and grade reduction problems, and, where his view from the train was circumscribed, he made many trips in automobiles through the mountains, studying the topography. He organized surveying parties, appointed a Superintendent of Construction, and personally directed the work. He revised the existing schemes for grade reduction between Sherwood, Tenn., and Paducah, Ky., by way of Nashville and Hollow Rock Junction.

During his term of office a considerable portion of this work was begun, some of it was executed, but the breaking out of the war with Germany compelled the stoppage of most of it. However, pending the completion of the grade reduction plan, the tonnage of trains was greatly increased by the purchase of larger engines and the use of helping engines at points where they had not been utilized previously.

Mr. Peyton organized an Agricultural Department of the Railway, bought demonstration farms in a number of counties, established modern farming methods thereon, and, under the direction of a Special Agricultural Agent, these farms were instrumental in greatly improving farming methods throughout the South. He made many trips over the road, speaking to citizens and at Farmers' Institute meetings.

On the assumption of control of the railroad by the Government, Mr. Peyton was called on to make several studies for the Regional Director of the Southern Region, and reported on the navigation scheme on the Mississippi River between St. Louis and New Orleans, and on the Black Warrior River from the coal fields of Alabama to Mobile and New Orleans. He was peculiarly fitted for this assignment, having previously made a study of inland navigation and written a book, entitled "The American Transportation Problem", which dealt particularly with comparisons between railway and inland transportation by water.

Before he assumed the Presidency of the Railway, the project of building the Paducah and Illinois Railroad, which included a bridge over the Ohio River at Metropolis, Ill., had taken shape, and work had begun, but, on the breaking out of the war, it was stopped. Mr. Peyton succeeded in re-organizing the work, and, through his efforts, it was brought to a successful conclusion, under the direction of C. H. Cartlidge, M. Am. Soc. C. E., Bridge Engineer of the Chicago, Burlington and Quincy Railroad, and Chief Engineer of the Paducah and Illinois Railroad, who, however, died before the bridge was entirely completed.

Mr. Peyton did not remain with the Nashville, Chattanooga and St. Louis Railway under Federal control, but retained the Presidency of the Corporation. Just prior to this change, however, he undertook, for the railway, the construction of the Old Hickory Powder Spur for the United States Government, which was completed in a remarkably short time. After the institution of Federal control of the railways, Mr. Peyton made application for a Commission in the Engineering Corps, desiring to enter the American Expeditionary Forces.

Mr. Peyton was a very devout member and lay-reader of the Protestant Episcopal Church. He was a Trustee of the University of the South, an Episcopal School, at Sewanee, Tenn., of George Peabody College for Teachers, at Nashville, Tenn., a Director in the Andrew

Jackson Memorial Association, in the Monteagle Assembly and Summer School, and in the Southern Howard Association, and was active in all.

He was President of the Nashville Section of the Engineering Association of the South in 1916, was a Member of the American Railway Engineering Association, of the Tennessee Historical Society, and the Tennessee Academy of Science. He was also a Member of the Old Oak Club, the Rotary Club, the Hermitage Club, and the Commercial Club, in Nashville.

He was intensely public spirited, religious, and charitable, devoting much of his time and money to these causes.

Mr. Peyton came of ancestors who were distinguished for their statesmanship and service to the State of Virginia and the Nation. He was very proud of Virginia, and took a deep interest in her welfare and in the welfare of the South. He was especially devoted to young men, and attached many of them to him through his kindness and consideration for their advancement. It was always a source of regret to him that his parents made their excursion to Missouri, and of joy that they returned to their beloved Virginia after so short a stay in the West.

Mr. Peyton was never married. His death occurred at his home on West End Avenue, in Nashville, Tenn., on the morning of September 14th, 1918. Two elder sisters, Misses Elizabeth M. and Sallie R., survive him, being now temporarily with their nephew, Wythe M. Peyton, near Jennings, Va. There are also two elder brothers, William M. Peyton, of Martinville, Va., and Carlton P. Peyton, of Charleston, W. Va. His other nephew, the Rev. William P. Peyton, is with the American Expeditionary Forces in France.

Mr. Peyton was elected a Member of the American Society of Civil Engineers on June 1st, 1909.

PAPERS AND DISCUSSIONS CURRENT IN PROCEEDINGS

"Cement Joints for Cast-Iron Water Mains." CLARK H. SHAW	Mar.,	1917
Discussion	May, Aug.,	"
Progress Report of the Special Committee to Codify Present Practice on the Bearing Value of Soils for Foundations, etc.	Aug.,	"
Discussion	Nov.,	"
Final Report of the Special Committee on Steel Columns and Struts	Dec.,	"
Discussion	Feb., Mar., Apr., Aug., Oct.,	1918
Progress Report of the Special Committee on the Regulation of Water Rights	Dec.,	1917
Discussion	Feb.,	1918
"Verification of the Bazin Weir Formula by Hydro-Chemical Gaugings." FLOYD A. NAGLER	Jan.,	"
Discussion	Mar., May, Aug., Nov.,	"
"Determination of the Duty of Water by Analytical Experiment." W. C. HAMMATT	Feb.,	"
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"The Economics of Steel Arch Bridges." J. A. L. WADDELL	Mar.,	"
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"Construction Methods Used in Building the Lower Reservoir Dam of the Balmorhea Project." VERNON L. SULLIVAN	Apr.,	"
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"Emergency Construction Work Due to War Conditions, With Especial Reference to the Construction Division of the Army." GEORGE W. FULLER	May,	"

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PROCEEDINGS

OF THE

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OF

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VOL. XLIV—No. 10

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ON THE REGULATION OF WATER RIGHTS: F. H. Newell, W. C. Hoad, John H. Lewis.

TO REPORT ON STRESSES IN RAILROAD TRACK: A. N. Talbot, A. S. Baldwin, G. H. Bremner, John Brunner, W. J. Burton, Charles S. Churchill, W. C. Cushing, Robert W. Hunt, George W. Kittredge, Paul M. LaBach, C. G. E. Larsson, G. J. Ray, Albert F. Reichmann, H. R. Safford, F. E. Turneaure, J. E. Willoughby.

◆

The Reading Room of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

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TELEPHONE NUMBER....................4600 Vanderbilt.
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* Appointed Director, October 8th, 1918, to fill the vacancy caused by the death of William R. Hill, M. Am. Soc. C. E.

Vol. XLIV. DECEMBER, 1918. No. 10.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PROCEEDINGS

This Society is not responsible for any statement made or opinion expressed in its publications.

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MINUTES OF MEETINGS

OF THE SOCIETY

December 4th, 1918.—The meeting was called to order at 8.30 P. M.; President Talbot in the chair; Chas. Warren Hunt, Secretary; and present, also, 88 members and guests.

The minutes of the meetings of October 16th and November 6th, 1918, were approved as printed in *Proceedings* for November, 1918.

J. H. H. Muirhead, M. Am. Soc. C. E., Lieut., Royal Engineers, addressed the meeting on "Personal Recollections of War Operations on Inland Waterways."

The Secretary announced the election of the following candidates on November 26th, 1918:

As Members

Norman Collyer, San Francisco, Cal.
William Smith Cone, Los Angeles, Cal.
George Herbert Herrold, St. Paul, Minn.

Aron Lancaster Hunt, Jacksonville, Fla.
Ely Champion Hutchinson, San Francisco, Cal.
Frank David Hutchinson, New York City
Ernest James Newton, Cleveland, Ohio
Edward Uhr Smith, Narberth, Pa.
Elwin Gerald Speyer, Buffalo, N. Y.
William John Moore Woolley, Caulfield, Victoria, Australia

As Associate Members

Harry Edward Anschutz, Atlanta, Ga.
William Carlyle Bailey, Philadelphia, Pa.
Elmer Ellsworth Baptiste, Jersey City, N. J.
Paul Cuno Berkefeld, Berkeley, Cal.
Byron Bird, Fort Dodge, Iowa
George William Borden, Goldendale, Wash.
Charles Edward Bradbury, Canton, Ill.
George Herman Brown, Beardstown, Ill.
Charles Stewart Carroll, Cincinnati, Ohio
Howard Henry Demmert, Philadelphia, Pa.
William Henry Ellison, San Francisco, Cal.
James Jervey Gantt, Toccoa, Ga.
Howard Ruggles Green, Cedar Rapids, Iowa
Edmond Walter Hammer, West Collingswood, N. J.
Carl Valdemar Hansen, New Madrid, Mo.
Roy Edward Hempel, Warren, Ohio
Volney Howard Henderson, Dallas, Tex.
John Ray Herbert, Kittanning, Pa.
John Louis Hermessen, Cincinnati, Ohio.
William Cullen Hirn, Lansing, Mich.
Joseph Groff Kenan, Valparaiso, Ind.
William Burris Knox, Lafayette, La.
Edward Louis Koch, Camden, N. J.
Charles Abraham Lass, Birmingham, Ala.
James Harold Leech, Cleveland, Ohio
William Stevenson Logan, Jr., Barksdale, Wis.
Mortimer Johnson McChesney, Charleston, W. Va
Crosby Jaquith McGiffert, Mobile, Ala.
Louis B. Manheimer, Charleston, S. C.
Ralph Inman Meeker, Cheyenne, Wyo.
Winthrop Warren Mellen, Chicago, Ill.
Richard Claxton Newbold, Wayne, Pa.
Ernest Nicholson, Bayonne, N. J.
Thomas James O'Connell, Baltimore, Md.
Albert Edward Paddock, Lowerotay, Cal.
Thomas Percy Pendleton, Washington, D. C.

George Ribeiro, Rio de Janeiro, Brazil
George Bible Richardson, Seattle, Wash.
George Braden Roberts, Pensacola, Fla.
Alexander Rose, Minneapolis, Minn.
Samuel Leigh Savidge, Portland, Ore.
Theodore John Schmidt, Camp A. A. Humphreys, Va.
Frederick Ernest Schnepfe, Centreville, Md.
John Alfred Stalfort, Baltimore, Md.
William Frederic Starks, Glen Cove, N. Y.
Thomas Algeo Stiles, Oroya, Peru
Howard Raymond Stocker, Camp Hill, Pa.
Rush McElroy Templeton, Thermopolis, Wyo.
Perry Thompson, Charleston, W. Va.
Harry Belmonte Thorn, Queens, N. Y.
James Hamilton Titus, Chicago, Ill.
Daniel John Henry Webb, New Haven, Conn.
John Alonzo Williams, Camden, N. J.
Henry Harrison Wilson, Pennsboro, W. Va.
Walter Charles Youngs, Edna, Tex.

As Associates

William Cook Haskell, New York City
Frank Louis Reynolds, New Orleans, La.
Charles Albert Steinle, New York City

As Juniors

Ovidio Benedicto Apeseche, Ann Arbor, Mich.
Charles Armstrong Clark, Kansas City, Mo.
Eugene Thompson Cranch, Erie, Pa.
Vincent Knowles Jones, East Las Vegas, N. Mex.
Elbert Saunders Tillotson, Brooklyn, N. Y.

The Secretary announced the transfer of the following candidates on November 26th, 1918:

From Associate Member to Member

Frank Foy Axtell, Tampico, Mexico
Edward Adam Beck, Goldsboro, N. C.
Edward Sorrel Bleck, Cienfuegos, Cuba
Burgis Greenacre Coy, Fort Collins, Colo.
Roland Parker Davis, Morgantown, W. Va.
Carroll Andrew Farwell, Boston, Mass.
Nicolay Knudtzon Fougner, Christiania, Norway
Felder Furlow, Charlotte, N. C.
Philip Guise, Islip, N. Y.

Raleigh Hortenstine, Memphis, Tenn.
Augustus Kempkey, Piedmont, Cal.
Earl Louis Mosley, Nitro, W. Va.
Samuel Murray, Portland, Ore.
Edward Pendlebury, Arlington, N. J.
Joseph Eugene Root, Akron, Ohio
Stanley Rush Sharts, Dayton, Ohio
William Warburton Knox Sparrow, Chicago, Ill.
Charles Hook Tompkins, Washington, D. C.
Joseph Weidel, Chicago, Ill.

From Junior to Member

Charles Burridge Hawley, Pittsburgh, Pa.

From Junior to Associate Member

Albert Mangum Alexander, St. Louis, Miss.
James Warren Ingalls, Hallowell, Me.
Harry Parker McKean, Denver, Colo.
Merton Miles Ogden, Am. Exp. Forces, France
Arthur Edward Prack, Toronto, Ont., Canada
George Peter Searight, Am. Exp. Forces, France
William Matthew Stieve, Washington, D. C.
Frederic Stevens Stow, Pittsburgh, Pa.

The Secretary announced the following deaths:

Augustus Jesse Bowie, of Yokohama, Japan, elected Member, November 1st, 1882; died May 20th, 1917.

James Currie Hallock, of Newark, N. J., elected Member, October 3d, 1906; died November 2d, 1918.

William Anthony Lydon, of Chicago, Ill., elected Junior, January 4th, 1888; Member, December 5th, 1894; died October 28th, 1918.

William Augustus Moncure, of Philadelphia, Pa., elected Junior, June 21st, 1894; Associate Member, October 7th, 1896; Member, June 5th, 1906; died October 3d, 1918.

Charles John Augustus Morris, of St. Paul, Minn., elected Member, October 3d, 1883; died October 27th, 1918.

Alexander Joseph Norris, of Lima, Peru, elected Member, October 3d, 1911; died May, 1918.

Albert Alonzo Robinson, of Topeka, Kans., elected Member, May 5th, 1880; died November 7th, 1918.

Harry Sidenius, of Calgary, Alberta, Canada, elected Associate Member, January 2d, 1912; Member, June 24th, 1914; died November 7th, 1918.

STANLEY DEAN, Capt., Q. M. C., U. S. A., of Chicago, Ill., elected Associate Member, April 1st, 1908; died in service (Camp A. A. Humphreys, Va.), October 2d, 1918.

ALBERT FRANCIS GEIGER, of Bridgeport, Conn., elected Associate Member, March 12th, 1918; died November 3d, 1918.

GUY VINCENT MCCLURE, of Oklahoma, Okla., elected Associate Member, April 4th, 1911; died October 23d, 1918.

EDWIN JAMES POTTER, of Bridgeton, R. I., elected Junior, October 1st, 1907; Associate Member, October 1st, 1913; died October 18th, 1918.

WARD HALL REAM, 1st Lieut., Engrs., U. S. A., of Oshkosh, Wis., elected Associate Member, April 18th, 1916; killed in action (France), October 4th, 1918.

EDGAR FIELD SMITH, of New York City, elected Associate Member, May 1st, 1907; date of death unknown.

WARREN WILLIAM UPSON, of Hartford, Conn., elected Associate Member, May 31st, 1916; died September 2d, 1918.

ERNEST CHARLES DEDICKE, 1st Lieut., U. S. A., of Utica, N. Y., elected Junior, November 28th, 1916; wounded in action (France); died July 15th, 1918.

Adjourned.

December 18th, 1918.—Because of the necessity of going to press with this number of *Proceedings* in advance of this meeting, the publication of its minutes must be deferred until January, 1919.

ITEMS OF INTEREST

Action by Executive Committee, November 22d, 1918, in Reference to Reconstruction Matters

A special meeting of the Executive Committee was held on November 22d, 1918, at which there were present Messrs. Kittredge, Alvord, Flinn, and C. W. Hunt. The members of the Committee of the Board appointed to keep the Board informed on all matters relating to Reconstruction Work were invited, and Messrs. Lewis and A. M. Hunt, of that Committee, were present; also, by invitation, Mr. Noble of the Committee on Development.

Mr. Flinn, as Secretary of Engineering Council, presented a statement of the action taken by Council at its meeting of November 21st, as follows:

"A communication* by Representative Moore, dated November 18, entitled 'Tentative Plan for Representation of Engineers at the National Capital' was presented. Mr. Moore presented the following resolutions which were seconded by Mr. Herschel, and, after discussion at length, were adopted:

"*Whereas:* The close of the war brings an emergency through the immediate demand for solution of reconstruction problems a large proportion of which are those of engineering; and

"*Whereas:* There is need for instant, active and constant representation of engineers at the seat of National Government;

"*Resolved:* That Engineering Council hereby establish a National Service Committee for such purpose; and

"*Resolved:* That Engineering Council refer the details of membership and financing of such committee to its Executive Committee, with power;

"*Resolved:* That Engineering Council appropriate $2 500 for the establishment of a Washington office and necessary expenses of such National Service Committee until December 31, 1918, providing the Executive Committee, after further consideration, deem that such appropriation is feasible."

The Executive Committee then adopted the following resolution:

Resolved: That the Executive Committee of the American Society of Civil Engineers heartily endorses the action taken by Engineering Council, and pledges the hearty co-operation of the American Society of Civil Engineers in the project.

A telegram, dated November 16th, which had been received from the Committee on Development then meeting in Chicago, was presented by the Secretary, urging action at Washington by properly accredited representatives of the Engineering Profession.

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* See page 1109.

Mr. Lewis, Chairman of the Committee on Reconstruction, presented a report, dated November 14th, 1918.*

On motion, the Report was received and ordered printed in *Proceedings,* together with the action taken by Engineering Council, and with an explanation that, in view of this action of Engineering Council, the recommendation of the Committee had not been carried out, but that a copy of the Report had been ordered sent to Engineering Council for its information.

American Engineers Appointed to Aid France in Making Reconstruction Plans.

An invitation has been extended by the French Society of Civil Engineers, with the approval of the French Ministries of Public Works, of Commerce, and of Armament, to the American Society of Civil Engineers to send a delegation to a Joint Engineering Congress to be held in Paris in December for the purpose of discussing technical matters pertinent to reconstruction work and the development of industry.

The Society has replied, accepting the invitation, and has invited the co-operation of the other National Societies of Mechanical, Electrical, and Mining Engineers.

The following representative engineers have been chosen from the American Society of Civil Engineers:

J. F. Case, M. Am. Soc. C. E., *Chairman*
George W. Fuller, M. Am. Soc. C. E.
A. M. Hunt, M. Am. Soc. C. E.
Nelson P. Lewis, M. Am. Soc. C. E.
George F. Swain, Past-President, Am. Soc. C. E.
George W. Tillson, M. Am. Soc. C. E.

The other National Societies have responded by appointing the following:

Charles T. Main, President, Am. Soc. Mechanical Engineers
L. B. Stillwell, M. Am. Inst. Electrical Engineers
E. G. Spilsbury, M. Am. Inst. Mining Engineers

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* See page 1112.

President Millerand, of the French Congress, has been notified by cable that the delegation would sail for France on the *S. S. Espagne* on December 5th, 1918.

"33 West 39th Street, New York,
"NOVEMBER 20, 1918.

"THE HONORABLE,
THE SECRETARY OF STATE,
Washington, D. C.

"SIR:—I have the honor to inform you that the American Society of Civil Engineers has been invited by the French Society of Engineers, with the approval of the French Ministries of Public Works, of Commerce and of Armament, to form a delegation of Engineers to attend a joint engineering congress for formulating plans for the restoration and development of French industry.

"The Society has accepted the invitation, and with the co-operation of the National Societies of Mechanical, Electrical, and Mining Engineers the following representative American engineers have been chosen:

"J. F. CASE, M. Am. Soc. C. E., *Chairman*
GEO. W. TILLSON, M. Am. Soc. C. E.
GEO. W. FULLER, M. Am. Soc. C. E.
A. M. HUNT, M. Am. Soc. C. E.
NELSON P. LEWIS, M. Am. Soc. C. E.
GEORGE F. SWAIN, M. Am. Soc. C. E.
CHAS. T. MAIN, President, Am. Soc. Mech. E.
L. B. STILLWELL, M. Am. Inst. Elec. E.
E. G. SPILSBURY, M. Am. Inst. Mining E.

"Arrangements are being perfected for this delegation to sail to France on the S/S *Espagne* on December second.

"While the members of the commission will be cordially welcomed by their French colleagues and be shown every courtesy, this Society feels, nevertheless, that the objects in view are of such great importance and so much illustrate the purpose for which the War was fought and won, as to warrant it in requesting the Department to support the commission, if not with its definite official approval, at least with an expression of its sympathetic and cordial interest.

"I have the honor to request, accordingly, that the Department will be good enough to give the Society, for the use of the mission, a letter to the American Ambassador in Paris in which the Society's representatives are introduced to the Ambassador and in which the Ambassador is requested to extend the mission such assistance and courtesies as may be consistent with the discharge of his official duties.

"I have the honor to be, Sir,

"Yours very respectfully,

"CHAS. WARREN HUNT,
"Secretary."

"DEPARTMENT OF STATE
"WASHINGTON
"NOVEMBER 30, 1918.

"THE HONORABLE WILLIAM G. SHARP,
AMERICAN AMBASSADOR, PARIS.

"SIR:—The Department is glad to present to you, at the instance of the American Society of Civil Engineers, Major James F. Case, Chairman, and Messrs. George Warren Fuller, George W. Tillson, Andrew Murray Hunt, E. Gybbon Spilsbury, Nelson P. Lewis, Charles T. Main, L. B. Stillwell, and George F. Swain, the bearers of this letter, who compose a mission selected by the Society in response to an invitation from the French Society of Engineers, approved by the Ministries of Public Works, of Commerce and of Armament, to meet in a joint engineering congress for the purpose of formulating plans for the restoration and development of French industry.

"It will be sincerely appreciated by the Society if you will put its representatives in touch with the Ministries of Public Works, of Commerce and of Armament, and extend them such assistance and courtesies as are consistent with the discharge of your duties. The Department attaches significance to their visit and trusts that their presence in France will be taken as evidence of America's desire to make real the ideals which have triumphed in the War.

"I am, Sir,

"Your obedient servant,

"ROBERT LANSING"

Report to Engineering Council

"NOVEMBER 18, 1918.

"TENTATIVE PLAN FOR REPRESENTATION OF ENGINEERS AT THE NATIONAL CAPITAL

"Opportunities for National and International service by the Engineering Profession, now and shortly to offer, are so many and great that the present seems most opportune to consider them. Further than the need for service, the present appears a more promising time than ever before for the Profession to take a part in Governmental affairs more in accordance with its dignity, its past service, and its looming importance.

"There offer two lines of work where engineers can most fitly serve:

"(*a*) Reconstruction Tasks;
"(*b*) National Department of Public Works.

"(*a*) *Reconstruction.*—In the flux of institutions surely coming with the return of this nation to the pursuits of peace, there will come many occasions where the public service may be hindered or advanced, and the real interests of the Profession greatly harmed or helped for the lack or presence of wise and intelligent representation of the Engineer's point of view.

"From the host of men drawn into bureaucratic employment, where they have acquired the unyielding mind of such service during War time, there will come, shortly, strenuous resistance to abatement of governmental functions or to the return of these to their normal paths.

"Further, there will come under reconstruction tremendous demands for engineering service in the ruined areas of the closing war.

"For such tasks American engineers are fitted, and Engineering Council, as the official agency of the National Societies, should be most useful, not alone in helping the people who need service, but also in securing the proper allotment and selection of American engineers. To this end it is suggested that the engineers about to visit France, at the invitation of the French Society of Civil Engineers, be requested to ascertain what is needed, particularly and immediately, of American engineers, or, in the event that this be impracticable, that the Council send a representative or representatives abroad for the purpose.

"For the above reasons, for the tender of service to the Nation, for the use of engineering knowledge and experience toward more economical and efficient administration, Engineering Council should establish a National Service Committee for the following general purposes:

"(1) To discover public services which may best be performed by Engineering Societies, to inform Engineering Council thereof, and, when desired, to offer the proper men for such service.

"(2) To speak authoritatively for Engineering Council before committees of Congress and departments of Government 'on all public questions of a common interest or concern to engineers' within such limitations as may be fixed by Engineering Council from time to time.

"(3) To give wide circulation among engineers, promptly, of first-hand information regarding pending legislation and executive actions which may affect the interests of engineers in any way.

"(4) To gather opinions of engineers upon matters arising for action within the field of the Committee.

"(*b*) *Department of Public Works.*—There has been for years in the minds of foresighted engineers a vision of the engineering work of the Nation consolidated in one department, under an engineer with rank of a Cabinet Minister as its head.

"Under such department the activities now distributed among many departments and bureaus should be gathered and directed, to the increase of efficiency, the reduction of duplication and interdepartmental friction. This has been proposed from time to time, notably by one of our members, Mr. Herschel, in his address as President of the A. S. C. E. It is a proposal to which theoretically there can be no logical opposition, but never before has there existed anybody capable of enlisting the united support of the engineers of the country.

"In the belief of the writer there has never been so favorable an opportunity as the present to initiate such a movement, nor so potent an organization to press it as Engineering Council.

"In the nature of things, such a radical reform will require time, perhaps years of agitation, but the present time seems opportune, and the proposed National Service Committee a fit medium to conduct the campaign.

"*Constitution of Committee.*—The National Service Committee should have for its chairman an eminent engineer, of experience and diplomacy, willing to reside in Washington so that he can be constantly in attendance during sessions of Congress. He should preferably be a man who has been in independent practice and is not closely connected with any one commercial interest. When not obliged to be in Washington, he should spend part of his time in traveling throughout the country, meeting local sections and societies of engineers, to keep them *en rapport* with pending, proposed, or desired legislation and with work of the Committee and other activities of Engineering Council.

"To support and guide the chairman there should be a committee of two from each Founder Society, with provision for representation of the other member societies if desired. Men of experience and tact should be chosen, distributed geographically as far as practicable, ready to respond to the call of the chairman in frequent visits to Washington as needed.

"*Expense.*—The chairman should receive a liberal salary and expense account. Other members of the committee should not be compensated, but should be reimbursed for traveling expenses on a liberal basis.

"*Office.*—A well-manned and equipped office should be maintained in Washington, with a secretary and abundance of help and the necessary equipment for copying and mailing, so that the chairman can communicate freely and quickly with all Engineering societies in the country, or in emergency with all members of the societies which are members of Engineering Council.

"*Result.*—The result will be to furnish the societies first-hand information upon all National public matters interesting them, and to enable Engineering Council, as representing the engineers of the country, to act effectively and quickly.

"All pending legislation interesting the Profession in general, or the members thereof in particular localities, should be closely watched, and the substance of any Bills of the character above outlined communicated to the Profession immediately on introduction, so that, if it be decided vital either to antagonize or to support, proper measures might be promptly taken to the desired end.

"Items of immediate importance are:

(*a*) Reconstruction;
(*b*) Department of Public Works;
(*c*) Government policies affecting the practice of engineering;
(*d*) Work of National Research Council and Engineering Foundation.

"The above outline is submitted with confidence that it will open a way for more efficient administration of public affairs, and bring to the Engineering Profession new and greater opportunities for patriotic service.

"PHILIP N. MOORE."

Report of Committee on Reconstruction

"N. Y., November 14, 1918.

"To the Board of Direction
of the American Society of Civil Engineers.

"Gentlemen:—Your Committee, appointed in accordance with the action taken by the Board on October 8th, which Committee is 'to keep itself and the Board informed of any Governmental or other programme looking to the reconstruction or rehabilitation, after the war, of the engineering resources of the country', submits this progress report:

"The conditions which this Committee was created to consider have come with startling suddenness, and no definite action appears to have been taken by the Federal Government to meet them. The first step in this direction will involve legislative action. Two bills have been presented to Congress, Senate Bill 4968, known as the Overman Bill, which provides for an administrative committee of five to examine into problems and conditions arising out of the war, with a view to meeting as far as possible such problems and conditions before their solution is actually forced upon the Government, and the Weeks-Madden Concurrent Resolution, providing for a joint congressional committee on reconstruction, consisting of three senators and three representatives of each of the two principal parties. The two bills name eleven different problems, and an attempt has been made to indicate the scope of each in the tabular analysis which is submitted herewith. Your Committee has been informally advised that no serious consideration will be given to these bills at the present session.

"It appears to your Committee that the Board of Direction of the Society should without delay urge prompt action by Congress, and to this end we submit for the consideration of the Board a draft of resolutions containing certain specific recommendations. In preparing these resolutions an effort has been made to avoid any questions of a political nature, and there is no suggestion that any new departments be created, believing that the Society should at this time simply call attention to the things to be accomplished rather than the method of their attainment. The resolutions emphasize the fact that such plans and policies as may be adopted must be carried out largely by engineers, and that engineers should therefore take a prominent part in their formulation.

"Tabular analysis of the two measures before Congress and draft of proposed resolutions are attached.

"Respectfully,

"Nelson P. Lewis, *Chairman.*
"A. M. Hunt.
"John W. Alvord.
"Samuel T. Wagner.
"Chas. Warren Hunt."

“A COMPARISON OF THE PRINCIPAL FEATURES OF THE OVERMAN BILL AND THE WEEKS-MADDEN CONCURRENT RESOLUTION.

“(While several subdivisions have been used, nearly all of them are intimately connected with engineering.)

	“OVERMAN BILL.	“WEEKS-MADDEN RESOLUTION.
“Engineering:	Conservation and development of natural resources. Inland transportation by rail and water. Communication by telephone, telegraph, and wireless.	Public utilities, including railroad policy and communication by wire. Production and distribution of fuel.
“Commercial:	Foreign trade—its development and financing. Raw material—its supply and distribution.	Foreign trade—its development and financing. Existing and new industries, raw material; encouragement of private enterprise in development of natural resources; protective tariff.
“Manufacturing:	Reconverting industries engaged in war work to normal production.	Demobilization of industrial and military war resources; disposal of surplus properties and supplies; conversion of munition industries to those of peace, including that of war workers.
“Shipping:	Financing and development of merchant marine.	Shipping and ship yards; continued ownership; sale or leasing of both ships and yards.
“Social:	Redistribution and employment of labor; labor problems growing out of demobilization.	Unemployment after war; labor disputes; employment of discharged soldiers and sailors on public works; permanent employment agencies. Housing conditions, and disposition of houses built by Government during the war.
“Administration:	Reorganization of Government departments, commissions, etc., to put them on economical and efficient peace basis.	
“Finance:		Capital and credit; trusts and combinations; federal loans to private enterprise; supervision of capital issues.
“Education:	Technical education and industrial research, in order to develop and strengthen industry.	
“Agriculture:		Continuing price fixing of food products; loans to farmers; distribution of food products; allotment of lands to returned soldiers and sailors.
“Legislative Action:	Consolidation of acts relating to same subjects now in various places in statutes.	War legislation now in force, its repeal, extension, or amendment.

"DRAFT OF PROPOSED RESOLUTIONS FOR CONSIDERATION BY THE BOARD OF DIRECTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS:

"*Whereas:* The period of reconstruction or rehabilitation, precipitated by the sudden change from war to peace, already is or soon will be here in advance of the adoption of a definite policy and programme to meet the new conditions; and

"*Whereas:* The engineering resources and activities of the country will be profoundly affected by this change, and there is imperative need of their wise development and intelligent control in which the engineering profession must take an active part and assume large responsibilities; therefore, be it

"*Resolved:* That the Board of Direction of the American Society of Civil Engineers respectfully but most earnestly requests the Congress of the United States to enact without delay such legislation as may be required to enable the President, the heads of the several departments, and such commissions or committees as may be created to formulate comprehensive plans to meet the new conditions, to the end that the change from war to peace may be effected with as little confusion and disturbance as possible with due recognition of the economic and social changes which will inevitably result from the world war.

"*Resolved:* That such plans should include the following:

"The proper co-ordination of means of transportation by rail, water, and highway, and possibly by air routes.

"The effective co-ordination of all means of communication by post, telegraph, telephone, and wireless, so that each may supplement the others and insure their free and effective use.

"The establishment of standards for the quality of water supplies and for such treatment of sewage and trade wastes as will prevent undue pollution of streams, rivers, and harbors.

"Control of the general planning and housing of industrial communities.

"The extension of the field of the Reclamation Service to include the drainage of swamp lands and the reforestation of cut-over areas.

"The development, control, and conservation of natural resources in such a manner as to insure adequate output, stimulate essential enterprises, and increase the national wealth.

"The development of industrial chemistry, to the end that recent progress made in supplying our own needs may be continued and wasteful methods of manufacture may be corrected.

"The adoption of just and consistent policies with respect to the supervision and control of public utilities and standardization of methods in making physical valuations.

"Provisions which, while preventing the exploitation of labor and reducing the scale of wages below a fair minimum, will tend to distribute the labor supply and thus permit the carrying out of many much needed but deferred improvements.

"Resolved: That, in view of the intimate relation to engineering of the problems herein named, of the part which engineers must take in the execution of such policies and plans as may be adopted, and of the part which they should take in their formulation, assurance is given that the engineers of the country will endeavor to assist in the wise solution of the difficult problems confronting us, and to render the same patriotic service in time of peace that they have given in time of war.

"Resolved: That a copy of these resolutions be sent to the President, members of the Cabinet, members of Commissions dealing with war problems, and to each Senator and Member of the House of Representatives."

"Engineering Council
"Engineering Societies Building
"29 West Thirty-Ninth Street
"New York

"November 15, 1918.

"The President,
"The White House,
"Washington, D. C.

"Sir:—I am advised that you have under consideration the appointment of a Reconstruction Commission to develop a comprehensive program for the Nation's conversion from a war to a peace basis.

"As Chairman of Engineering Council, I respectfully ask that you consider the appointment of at least one engineer upon this commission, basing my recommendation upon the fact that all construction and practically all manufacturing is under the management of engineers.

"Engineering Council is an organization of National Technical Societies of America, created to provide for consideration of matters of common concern to Engineers, as well as those of public welfare in which the Profession is interested, in order that united action may be possible. It represents the four great National Engineering Societies, comprising over 35 000 members, including practically all of the prominent engineers of the country.

"It may be pertinent to add that the personnel of Engineering Council, consisting of 24 members, is without exception men who occupy prominent positions as administrators of engineering problems or undertakings.

"Respectfully submitted,

"J. Parke Channing,
"Chairman"

"THE WHITE HOUSE
"WASHINGTON

"20 NOVEMBER, 1918.

"MY DEAR MR. CHANNING:—I have your letter of November 15th, which Mr. Rickard has been kind enough to hand me. You may rest assured that I realize what a service engineers can render in reconstruction problems from time to time. We are handling reconstruction questions just now by a process of consultation between existing instrumentalities, which I hope will prove useful and effective.

"Cordially and sincerely yours,

"WOODROW WILSON."

"MR. J. PARKE CHANNING,
ENGINEERS' COUNCIL,
29 WEST 39TH ST., NEW YORK."

Preliminary Report of the Committee on Development

CHICAGO, ILLINOIS,
NOVEMBER 16, 1918.

TO THE BOARD OF DIRECTION,
AMERICAN SOCIETY OF CIVIL ENGINEERS:

In accordance with the provisions of your resolutions adopted June 18th, 1918, your Committee on Development presents the following preliminary report:

The initial meeting of the Committee scheduled for October 31st, was postponed, because of the influenza epidemic. The meeting was held in Chicago, Illinois, on November 14th, 15th, and 16th, 1918, and, through the courtesy of the Western Society of Engineers, in its rooms in the Monadnock Block.

There were in attendance: ONWARD BATES, Chicago, Ill., *Chairman;* President ARTHUR N. TALBOT, Urbana, Ill. (*ex officio* member);

ANDERSON, GEORGE G., Los Angeles, Cal.
BRILLHART, J. H., Dallas, Tex.
BROWN, BAXTER L., St. Louis, Mo.
BUTLER, GEORGE, San Diego, Cal.
CUMMINGS, ROBERT A., Pittsburgh, Pa.
DARLING, W. L., St. Paul, Minn.
DARROW, FRANK T., Lincoln, Nebr.
HAEHL, H. L., San Francisco, Cal.
HALL, JOHN L., Seattle, Wash.
HANSEL, CHARLES, New York, N. Y.
HOLLAND, CLIFFORD M., Brooklyn, N. Y
HOYT, WILLIAM H., Duluth, Minn.
HUMPHREY, RICHARD L., Philadelphia, Pa.
MASON, GEORGE C., Portland, Ore.
NETHERCUT, EDGAR S., Chicago, Ill.
NOBLE, FREDERICK C., New York, N. Y.
PERRILLIAT, ARSÈNE, New Orleans, La.
PEW, ARTHUR, Atlanta, Ga.
RALSTON, J. C., Spokane, Wash.
THOMAS, E. B., Cleveland, Ohio.
TILDEN, C. J., Baltimore, Md.
TINKHAM, S. EVERETT, Boston, Mass.
WILKINSON, THOMAS L., Denver, Colo.
*WILLIAMS, GARDNER S., Detroit, Mich.

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* Absent on November 14th, 1918.

Messrs. Paul G. Brown, New York, N. Y., H. R. Safford, Chicago, Ill., and George R. Putnam, Washington, D. C., were not in attendance.

The sessions on November 14th, were occupied principally in a general discussion of the work of the Committee.

Mr. E. T. Howson was elected Secretary, and President Talbot announced the appointment of the following Executive Committee:

ONWARD BATES, *Chairman*

BAXTER L. BROWN	E. S. NETHERCUT
W. L. DARLING	FREDERICK C. NOBLE
H. L. HAEHL	H. R. SAFFORD

At the sessions of November 15th, the Committee considered at length the sub-divisions of its work, and unanimously agreed to the following:

Tentative Outline of Committee Work.

I.—Technical Activities

1.—Meetings, Papers, and Committee work.
2.—Sections or Divisions of the Society for Specialized Lines of Work.
3.—Co-operation with Specialized Engineering Societies and Other Organizations.
4.—Standards in Engineering Practice.

II.—Internal Relations and Local Associations

1.—Local Associations.
2.—Co-operation Between the Society's Local Associations and Those of Other National Societies and Local Societies.
3.—Re-arrangement of the Grades of Membership.
4.—Student Engineers.
5.—Young Men of the Profession.
6.—Personal Service Bureau.

III.—External Relations with the Engineering Profession

1.—With Other National Societies and Related Organizations.
2.—With Local Societies Other than the Relations Referred to in Section II.
3.—Amalgamation of Engineering Societies.
4.—American Engineers in Foreign Service.

IV.—Relations to Public Affairs

1.—Professional Status of the Engineer
    a.—Definition of the Engineer
    b.—Education of the Engineer
    c.—Professional Ethics
    d.—Service of the Engineer to the Nation, the State, and the Community

2.—Legal Status of the Engineer
   a.—Licensing
   b.—Legislation and Patent Laws
   c.—Arbitration and Expert Testimony

3.—Public Status of the Engineer
   a.—Publicity
   b.—Public and Industrial Affairs
   c.—Development of Natural Resources
   d.—Co-ordination of Government Engineering Activities

The Committee adopted the following rules for its government, to take effect at close of the meeting:

RULES FOR THE GOVERNMENT OF THE COMMITTEE ON DEVELOPMENT

Duties of the Executive Committee

To act on matters referred to it by the General Committee.

To aid and advise the Chairman.

To attend to the details of the time, place, and arrangements for meetings.

To decide questions of jurisdiction or precedence where the consideration of subjects by sub-committees seems to conflict or overlap.

To allot additional subjects or to make proposals to sub-committees.

To conduct letter-ballots when it is desired to vote by letter-ballot.

To revise, condense, and suggest changes in the wording of the discussion and proceedings for the Committee's permanent record, and to obtain the approval of changes from participating members of the Committee; also, to pass upon the form of the reports of the Committee before being forwarded to the Board of Direction.

To prepare and transmit to technical journals statements of the progress of the Committee work, reports of the meetings, and such other information as the Committee decides to offer to such journals for publication.

In general, to perform any duties which by nature or custom would be passed upon by the Executive Committee.

Not to decide on matters of policy or to make conclusions for the Committee as a whole.

Rules of the Committee on Development

Officers.—The officers of this Committee on Development shall be a Chairman, appointed by the President, and a Secretary, elected by the Committee, who shall assume their duties immediately after appointment.

Duties of Officers.—The Chairman shall preside at all meetings of the Committee, appoint all sub-committees unless otherwise directed, and be *ex officio* a member of all sub-committees.

The Secretary shall be expected to attend all meetings of the Committee, keep a roll of the members in attendance, and record the minutes in a book kept for that purpose.

(*a*)—He shall conduct the correspondence, and receive all communications addressed to the Committee, and furnish each member a complete copy of all communications.

(*b*)—He shall read the minutes at all meetings, and shall issue notices for all meetings and promptly inform sub-committees of their appointments and duties.

(*c*)—He shall keep a record of all expenses of the Committee. He shall prepare an abstract of the minutes of all meetings to be forwarded to each member and to the Secretary of the Society, and shall perform such other duties as may be required of him.

Expenses.—All matters pertaining to the expenses of this Committee shall be referred to the Executive Committee for appropriate action.

Meetings.—Meetings may be called at the option of the Chairman or at the request of the majority of the Committee; due notice of such meetings to be given to the Secretary of the Society and to the members of the Committee.

Quorum.—Two-thirds of the membership of the Committee shall constitute a quorum for the transaction of business at any meeting. Provided if at any called meeting a smaller number, not less than nine, of the Committee be present they may consider the matter before the meeting, but no action shall be approved without a majority affirmative vote of the Committee by letter-ballot.

Ballots.—All ballots are to bear the signature of the member voting, and are to be opened and canvassed by a sub-committee of the Executive Committee.

Reports.—No final action on a report of this Committee may be taken except at a meeting called for that purpose. Any report shall receive the approval of a majority of the Committee. A record of the vote shall be submitted with the report.

The sessions on November 16th were devoted principally to the preparation of the preliminary report and the immediate work of the Committee.

By resolution, the following Committees were created, and the Chairman, after consultation with the Committee, appointed the following as members thereof:

I.—On Technical Activities:

ROBERT A. CUMMINGS, *Chairman* GEORGE R. PUTNAM.

The Chairman of Sub-committee No. 1 is authorized to name three other members from the Committee.

II.—On Internal Relations and Local Associations:

Frederick C. Noble, *Chairman*

Richard L. Humphrey	Clifford M. Holland
George G. Anderson	H. L. Haehl
Edgar S. Nethercut	George C. Mason
Gardner S. Williams	J. H. Brillhart.

III.—On External Relations with the Engineering Profession:

S. Everett Tinkham, *Chairman*

Thomas L. Wilkinson	Arsène Perrilliat
E. B. Thomas	H. R. Safford
William H. Hoyt	Arthur Pew

IV.—On Relations to Public Affairs,

1.—Professional Status of the Engineer.
2.—Legal Status of the Engineer.
3.—Public Status of the Engineer.

W. L. Darling, *Chairman*

J. C. Ralston	C. J. Tilden
Charles Hansel	John L. Hall
George Butler	B. L. Brown
Frank T. Darrow	Paul G. Brown.

This Sub-Committee may appoint its own divisions.

The Committee is undertaking through its Sub-Committees, a broad survey of the functions and purposes of the Society in its relation to its members, to its Fellow-Societies, and to the Public. The Committee earnestly urges the fullest discussion of the subject by the members of the Society, who are requested to communicate any matters of interest to the Secretary of the Committee.

It is the intention that the Sub-Committees shall analyze and study the available data and information, and the recommendations of these Sub-Committees will be considered by the Committee on Development.

The Committee will keep in close touch with the work of similar Committees of the other National Engineering Societies, and will endeavor to so co-ordinate its work as to be, as nearly as practicable, in harmony with their action on related matters of common interest. The Committee will thereafter submit its final report with its recommendations.

In order to assist the Sub-Committees in their work, it is expected that there will be a discussion of the subject at the Annual Meeting and also by the Local Associations. While the Committee will be glad to have a discussion of all the items on its programme, it believes that, in view of the limited time available at the Annual Meeting, the best results will be secured through discussion of the following subjects:

I.—Technical Activities.
II.—Relation of the Society to its Local Associations.

III.—Relation of the Society to other National Societies and Related Organizations.

IV.—Relation of the Engineer to Public Affairs.

The following resolution was adopted:

"Resolved that it is the sense of this Committee that the American Society of Civil Engineers should adopt the principle of becoming an active national force in economic, industrial, and civic affairs."

Because of the urgency and importance of reconstruction, the Committee adopted the appended resolution addressed to the Executive Committee of the Board of Direction:

"The sudden ending of the World War has made necessary immediate action by the Federal Government looking to the solution of the problems of reconstruction and resumption of Peace Conditions. Various bills have been and are being prepared for providing the necessary administrative powers.

"The world has clearly demonstrated the supreme importance of Engineering work and it may be reasonably expected that the services of the engineer will be fully as important for reconstruction, therefore it is necessary that in the drafting of bills for purposes of reconstruction work the engineering profession should be consulted. This will probably not be done, at least to any important degree, unless forceful and co-ordinated work is done at Washington by properly accredited representatives of the engineering profession. We are not fully advised as to what actual work is now being done by our Society or others, and we do not assume that you or others of our Official Staff have failed to appreciate the great need of concentrated effort to aid our Country and others as also our profession at this turning point so full of portent for the world.

"We, however, feel that it is our duty to our Society and to our Country to earnestly urge at this time that prompt action be taken in providing means for keeping at Washington representatives of the Engineering Profession charged with the duty of keeping fully advised as to all matters in which the Engineering Profession should have a voice and of attempting to secure participation by engineers in the planning of the methods of dealing with reconstruction problems by governmental agencies or otherwise, including the drafting of bills and in the carrying out of the work of reconstruction.

"We suggest that the matter be taken up through The Executive Committee, The Committee on Reconstruction, or The Committee on Public Affairs of The Engineering Council, or by all of these agencies, and that active work be done at Washington at once."

The Committee trusts that each member of the Society will assume the responsibility of giving to the Committee whatever information he may have, and do everything in his power to aid the Committee in its work.

The Committee adjourned to convene in New York City on Monday, January 13th, 1919, preceding the Annual Meeting.

This report is respectfully submitted by the Committee.

Onward Bates, *Chairman.*

E. T. Howson, *Secretary.*

Reconstruction Congress of War Service Committees

On December 4th, 5th, and 6th, 1918, a Reconstruction Congress of War Service Committees was held at Atlantic City, N. J., under the auspices of the United States Chamber of Commerce, the object being to recommend "what American business ought to do for the Government and what the Government ought to do for American business".

Preliminary to the opening of the Congress, meetings of the various committees were held, at which each committee drafted resolutions setting forth the reconstruction needs of the industries represented by it, and these resolutions, after approval by a Clearance Committee of Ten, were presented to the Congress at its final session on December 6th, for approval and adoption.

At the opening session on December 4th, addresses were made by Harry A. Wheeler, President of the United States Chamber of Commerce, Charles M. Schwab, Director of the Emergency Fleet Corporation, and the Hon. William C. Redfield, Secretary of Commerce, who spoke on "Our Opportunity and Obligation in International Trade". At the second session, on December 5th, the Congress was addressed by Mr. John D. Rockefeller, Jr., and a paper prepared by James A. Farrell, President of the United States Steel Corporation, was also read. The final session, on December 6th, was opened by an address by Mr. Paul M. Warburg, who spoke on "Finance After the War".

Among the resolutions adopted by the Congress before its final adjournment were those authorizing the sending of a commission to study the reconstruction needs of European countries and to assist the American peace delegates in working out economic problems, if such assistance is desired; others declared opposition to Government control of railroads, telephones, telegraphs, and cables, recommended the establishment of a merchant marine, the prompt adjustment of war orders on the part of the Government and contractors, etc., etc.

In connection with this Congress, attention is called to the report of the Reconstruction Committee of the Society published in this number.*

Dinner to Mr. Ambrose Swasey by United Engineering Society

A dinner was given at the Engineers' Club on November 14th, 1918, by the United Engineering Society, in honor of Ambrose Swasey, Past-President, Am. Soc. Mech. Engineers, in recognition by the Engineering Profession of his large gifts to the Engineering Foundation Board. The committee in charge consisted of Messrs. E. Gybbon Spilsbury, Chairman, Charles Warren Hunt, Bradley Stoughton, Calvin W. Rice, and F. L. Hutchinson, and those invited included the governing bodies of the four Founder Societies, the Engineering Foundation Board, the Library Board, Engineering Council, and officers of the Engineers' Club.

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* See page 1112.

Charles F. Rand, President of the United Engineering Society, presided, and there were present 72 persons, including 21 Presidents and Past-Presidents of the Founder Societies.

Addresses were made by President Robert S. Woodard, of the Carnegie Institution, of Washington, Robert W. Hunt, M. Am. Soc. C. E., of Chicago, Ill., Mr. Swasey, and Dr. Michael I. Pupin, Chairman of Engineering Foundation, who made the closing address.

New York Meetings Committee

At its meeting of October 8th, 1918, the Board of Direction accepted the resignation of Clifford M. Holland, M. Am. Soc. C. E., as Chairman and member of the New York Meetings Committee. Mr. Holland has been appointed a member of the Committee on Development of the Society and felt that it would be impossible to give the time necessary to carry on the work of the two Committees. The Board of Direction has appointed Charles Gilman, M. Am. Soc. C. E., to succeed Mr. Holland as Chairman, and Ralph R. Rumery, M. Am. Soc. C. E., to fill the vacancy caused by his resignation. The personnel of the Committee as organized at present is as follows: Messrs. Charles Gilman, Chairman, J. B. French, Arthur W. Tidd, J. O. Eckersley, E. N. Layfield, E. B. Besselievre and Ralph R. Rumery.

Engineering Societies Employment Bureau

Under the direction of Engineering Council, the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, have established the Engineering Societies Employment Bureau, under the management of their Secretaries. One of the purposes of the Bureau is to keep in touch with all engineering firms, with a view of supplying them with desirable men.

Plans are now under way to assist in placing men who are retiring from Government Service.

The Bureau is not intended to be exclusively for the benefit of members of the Founder Societies; non-members who are introduced properly will also be registered.

Further information, registration forms, etc., may be obtained from Walter V. Brown, Manager, Engineering Societies Employment Bureau, Room 903, Engineering Societies Building, 29 West 39th Street, New York City.

Classification and Compensation of Technical Engineers in Railroad Employ

On February 28th, 1918, Engineering Council presented a communication to the Railroad Wage Commission at Washington, which contained arguments relative to consideration of the compensation of professional engineers and engineering assistants on railroads, and an abstract of this communication was published at that time.*

The following letter, addressed to the Hon. William G. McAdoo, Director General of Railroads, by Engineering Council, pertaining to the same subject, may be of interest to members of the Society, especially to those who have to do with railroads:

"November 20, 1918.

"Hon. William G. McAdoo,
"Director General of Railroads,
"Washington, D. C.

"Sir.—Your connection with the construction and management of railroads in years gone by as well as your present directorship, have unquestionably made you familiar with the essential functions in the construction, maintenance, development, operation, and management of railroad systems performed by the professional Civil, Mechanical and Electrical engineers of various ranks and their technical assistants. Such knowledge must be possessed, also, at least in a general way, by your present staff. Nevertheless, a number of engineers have brought to the attention of Engineering Council the fact that, upon scanning the schedules in 'Wages of Railroad Employees' and supplements thereto, no mention is found of the men performing engineering services under the Director General of Railroads. This numerically small but functionally most important group of employees is ignored; they fall under 'not otherwise provided for'.

"There may be reasons of which Engineering Council is not informed; but it seems more likely that the failure to accord to the technical engineers suitable classification is due to accident or even to the oversight which too often is the reward for quiet industrious modesty in competing with insistent organized demands.

"Specifically it is requested that all technical engineers be given suitable separate classification with rates of compensation in accord with their duties and the expense to which they have been put for their education and their training in preparation for their present duties and responsibilities. In many cases these technical men are now receiving less pay than men whom they direct, for whom they are responsible, and upon whom there are made no such demands for personal qualifications, expensive education, and previous training.

"Without disparagement to any other class of railroad servants, and for the good of the service, Engineering Council, representing the great National Engineering Societies, having thirty-five thousand members in all branches of the Profession, asks early action upon the classification and compensation of civil, mechanical and electrical engineers and their technical assistants in the staffs of the railroads. Engineering Council feels assured that, having thus been brought to your attention, the matter will be properly adjusted.

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* *Proceedings*, Am. Soc. C. E., March, 1918, p. 243.

"Respectfully,

"Alfred D. Flinn,
"Secretary."

War Industries Board Removes Building Restrictions

Prior to November 21st, 1918, and subsequent to the signing of the armistice on November 11th, prospective builders were required to take out permits for all non-war construction from the State Councils of Defense. On the former date, however, the last restrictions on the building trades were removed by order of the War Industries Board, and, in the future, no licenses of any kind will be required for new construction. In this connection, it has been stated by Bernard M. Baruch, Chairman of the War Industries Board, that the Federal authorities are prepared to encourage and assist in all private construction without further delay.

Municipal Activities and the Engineer

In connection with the reconstruction plans now being made all over the United States, it is interesting to note that the Dallas, Tex., Chamber of Commerce has appointed Charles Saville, M. Am. Soc. C. E., to create and organize a municipal bureau to increase community spirit and character of citizenship, in order to effect successful business development of the community. Among other things, it is proposed to establish a Bureau of Industrial Relationship to study local labor problems and to adjust relations between employers and employes, and the fact that an engineer has been chosen by a municipality to do this work should be cause for congratulation to the Engineering Profession.

Extend the Use of the Metric System

The following resolution pertaining to a more extended use of the metric system in the trade and commerce of the United States, has been adopted by the United States Section of the International High Commission:

"The United States section of the International High Commission, having in view the present efforts to bring about the exclusive use of the metric system of weights and measures within the jurisdiction of the United States, resolves:

"1. That in the opinion of the section the adoption of that system would be productive of great advantage in the commercial relations of the United States with the other American Republics.

"2. That the secretary of the section be directed to communicate a copy of this resolution to the chairmen of the proper committees of the Senate and the House of Representatives."

In a statement relative to this subject, issued by the Treasury Department, it is reported, among other things, that the Commission regards the adoption of the metric system of particular importance to the United States, one of the main obstacles to documentary uniformity, as between this country and the Latin-American countries being the fact that the use of the metric system is not obligatory in the United States.

Report of Seattle Association's Committee on Relations to the Parent Society, on Matters to be Considered by the Committee on Development

The following report was adopted by the Seattle Association at its meeting on November 4th, 1918:

"SEATTLE, WASH., OCTOBER 26, 1918.

"TO THE SEATTLE ASSOCIATION OF MEMBERS,
AMERICAN SOCIETY OF CIVIL ENGINEERS.

"GENTLEMEN:—Your Committee on Relations to the Parent Society, to whom was submitted the matters relating to the proposed Committee on Development, beg to submit the following report: Owing to the necessity for speedy action, at a former meeting of the society, Mr. John L. Hall was appointed to represent the Seattle Association as a member of the Committee on Development.

"We recommend that the following communication, if approved by the Association, be addressed to the Committee on Development as outlining the views of the Association on some of the general topics to be considered by the committee. It will undoubtedly be necessary that further reports be made from time to time relating to practical problems of organization and to other questions, but it is thought wise that the present statement of general principles be presented at this time. The work of the committee will doubtless extend over a considerable length of time, owing to the exceptionally important duties devolving upon it. There will, therefore, in our judgment, be ample time to consider details at later meetings.

"It is a well known fact, at least to engineers, that the industrial and commercial development of the past century has been due to the application of scientific principles to such practical problems as manufacturing, transportation and means of intercommunication by telegraph and telephone, or, in other words, to the development of engineering. It is certainly true, therefore, to a very large extent at least, that modern conditions are due to the progress of engineering. One of the results of this progress, resulting in industrial growth and commercial development, has been the creation of enormous wealth, and this in its turn has given rise to many social, economic and industrial problems which still await solution. Hitherto, however, the engineer has largely confined his attention to the scientific and practical work of his profession and has not considered carefully the far-reaching results of his work nor taken any part in the reconstruction of society made necessary thereby, nor in the solution of the human problems arising therefrom. The time has come, however, when the engineer should not only follow his special branch of the profession, but should be prepared to enter wider fields. The correlation of technical problems with human interests must be increasingly of interest to the engineer. Having created in a large measure the wealth of the community, it is only right that he should have large influence in questions relating not only to its acquisition, but also to its use and distribution. Such problems should not be left entirely to those who have had no engineering training. To enter into this field will require many things. Among others, a broader education and a higher conception of the fundamental dignity and importance of his work. There should also be fostered a sense of the solidarity of the profession. The specialists must add to their intensive interest in their own kind of work an extensive interest in the work of other engineers and in the problems of the community and nation. There will be required, also, a more scientific and thorough-going organization of the engineering profession in order that its influence be given its proper place and weight.

"We trust, therefore, that the Committee on Development will take the broadest possible view of their functions and duties and will not limit themselves by any narrow interpretation of their instructions. The time has come for a broad survey of the entire field of engineering and the task before the committee is so to organize the engineering profession as a whole that it will take its proper place in the life of the nation. To this end, we commend to the committee the editorial published in *Engineering News-Record* of October 10th, entitled 'Preparing a Profession for a Great Opportunity.' The general tenor of this editorial and the principles laid down therein meet with our hearty approval. We believe, as therein stated, that the basis of the new organization must be 'the obligations of the profession and individual to the public.' We believe too that the working out of this aim and purpose may lead to the rebuilding of the entire engineering structure. We believe, further, that the foundation of such a rebuilding and reorganization must be the development of strong local organizations vested with adequate powers. The organization, in other words, must run from the ground up, and not from the top down. Only so, can the breath of life be infused into the organization and transform it into a living organism.

"We also urge that steps be taken to publish, either through the engineering press, or by means of bulletins, or both, very full reports of the discussions before the committee. In this way the engineering public and the committee will be kept in constant touch with each other so that when the report of the committee is adopted it will doubtless rest upon a sound basis of popular approval.

"There are many details to be considered in the carrying out of the few principles mentioned herein. We trust to be able to submit to your committee from time to time the opinions of this association on such problems as they may arise for discussion. We attach, however, a report made by the Seattle Association and published in the

Proceedings of the Society for October, 1917, with certain modifications thereof which we now think desirable, concerning certain features of organization.

"It is undoubtedly unnecessary to call attention to the epochal report of Dr. Mann on 'Engineering Education'. This report, in a chapter entitled 'The Professional Engineer', says many things which support the point of view we have endeavored to set forth herein, as is shown by the following quotations:

" 'Progress is being made toward the conception that there is one profession of engineer, in spite of its apparent division into the several well known branches.'

" '* * * There has arisen a pressing demand for men who can deal with labor and with business administration in the engineering spirit.'

" 'These new opportunities for the engineer have been gradually developing for a number of years but the profession as a whole has been slow to discern them. Therefore, as engineering expands into the new fields now opening before it, the conception that character, judgment, efficiency, and understanding of men are no less necessary than technical knowledge and skill will become more and more impelling. * * *'

"The above quotations are merely sufficient to indicate the new outlook of the engineering profession. It is for your committee to determine how the profession shall be organized so as best to give expression to its new ideals and afford scope to the new activities which seem to lie immediately before us.

"We desire, therefore, to close by urging the committee to give to the American Society of Civil Engineers the honor of leading in a great reorganization of the engineering profession.

"Respectfully submitted,

"A. H. Dimock,
Chairman."

Amended Report of Seattle Association's Committee on Relations to the Parent Society

The report of the Seattle Association's Committee on Relations to the Parent Society, printed in *Proceedings* for October, 1917, was amended by the Association, on October 26th, 1918, to read as follows:

"The report of Messrs. Bontecou, McDonald and Jonah contemplates an increase in the number of Local Associations, an extension of their functions, and suggests that the name be changed to Local Sections.

"The Seattle Association heartily endorses the spirit of the report and the greater part of the wording, as far as it goes, but it feels that sufficient responsibility has not been delegated to the Local Sections to carry out one of the main points the Committee has in view, that of making the Society truly National in character and in influence.

"As a means of securing this, it suggests that:

"*First.*—The annual meeting be composed of duly elected delegates from the local associations.

"*Second.*—All applications for membership be considered by the Local Section having jurisdiction before being acted upon by the Board of Direction.

"*Third.*—Professional papers be first presented to a local section except those that may be selected for annual meetings or conventions.

"*Fourth.*—A sufficient proportion of the annual dues be remitted to the sections to care for the necessary expenses.

"*Fifth.*—The work of the headquarters' office be confined to general administration, issuing the publications and arranging for annual meetings and conventions."

Transcontinental Airways

In connection with the contemplated establishment of the new air mail lines by the Post Office Department, the following description by Rear-Admiral Robert E. Peary, Chairman of the Committee on Aeronautic Landing Places of the Aero Club of America, of the proposed five transcontinental airways and the three coastal airways now being developed by the Club in its efforts to assist the Government in organizing the air mail service, may be interesting:

"1. The Woodrow Wilson Airway which is an almost straight line from New York to San Francisco, touching Cleveland, Toledo, Chicago, and other important cities on the way to San Francisco. The straight line has been generally approved because it presents the best principle of air travel, which can be done in a straight line, as the aviators can make their own route, flying over all obstructions.

"2. The Wright Brothers' Airway.—Starting from Washington, Fort Myer, where the Wrights made their first public flights, and through North Carolina, the State where the Wrights made the historic first flight, through Georgia, Alabama, Mississippi, Louisiana, Texas—with a station at San Antonio, where an airplane—a Wright machine—was used for the first time in history under conditions approximating warfare, then through New Mexico, Arizona, ending at San Diego, Cal.

"3. The Langley Airway.—Named after Professor Samuel Pierrepont Langley, the pioneer experimenter in aeronautics. It will start from Philadelphia, pass through Pittsburgh, Columbus, Dayton, Indianapolis, Rantoul, St. Louis, Kansas City—and then on to Santa Barbara, Cal.

"4. The Chanute and Bell Airway.—Named after the American experimenters in aviation, Octave Chanute, who encouraged and assisted the Wright brothers, and Alexander Graham Bell and Mrs. Bell, who paid for the early experiments of Glenn H. Curtiss. It will extend from Boston, Mass., to Seattle, and Portland, Ore., touching Albany, New York, Syracuse, Rochester, Erie, Buffalo, Detroit, Grand Rapids, Mich.; Minneapolis, Minn.; Bismarck, N. D.; Great Falls, Mont.; and other cities along the route.

"5. The Rodgers Airway.—Named in honor of Calbraith Perry Rodgers, the American aviator who was the first to make a transcontinental flight, in 1911. It will extend from Newport News and Norfolk, Va., to Los Angeles, Cal., touching the important cities and towns on the way.

"6. The Atlantic Airway will extend from Bangor, Me., to Key West, Fla., and will touch every city on the Atlantic seaboard.

"7. The Gulf Airway will extend from Key West to the mouth of the Rio Grande, following the coast and touching every city on the Gulf seaboard.

"8. The Pacific Airway will extend from San Diego to Puget Sound, following the coast line, touching every city on the Pacific seaboard."

It is stated that the proposed new air lines can be established almost immediately by the employment of the highly trained aviators and mechanics now being released from military duty by the War Department, who are anxious to enter the mail service, and by the use of the recent types of aeroplanes now available for commercial purposes. Among these are the Handley-Page machines which can carry 1½ tons of mail matter at the rate of 100 miles an hour, the De Havilands carrying 1 000 lb. of mail at 140 miles per hour, as well many other types easily adaptable to the mail service.

The fact that the aero mail service between New York, Philadelphia and Washington is now an established fact and that the New York-Chicago line will soon be in service, seems to be indisputable evidence that extension of the service will soon open a new field for engineers as well as aviators.

A Proposed Water Code for Arizona

Members interested in water-rights legislation will find a brief on the subject in a Proposed Water Code for Arizona, prepared by G. E. P. Smith, M. Am. Soc. C. E., Professor of Irrigation Engineering, University of Arizona, and issued as a circular by the Extension Service of the College of Agriculture. The proposed code is similar to those of Wyoming, Oregon, and other Western States, and outlines briefly the proposed legislation and discusses some of the features of the water codes of other States.

Engineering Congress, Java, 1919

A preliminary notice of the General Engineering Congress to be held in Java, in 1919, under the auspices of the Royal Netherlands Institute of Engineers, together with a short description of the Dutch East Indies and a brief statement of the scope of the Congress, was published in *Proceedings* for August, 1918, page 610.

Further details have been received recently and are published here for the information of the membership.

The Congress is to be held at Batavia, in September, 1919, and is to continue for six days. Subscriptions are open to associations, companies, and private individuals, and entitle the subscriber to admission to all meetings of Congress, to copies of all reports on, and of papers to be presented at, the Congress, and to take part in the discussions thereof, the subscription fee being 15 guilders (about $6.00), payable in advance. The official language of the Congress is to be English and Dutch, the subjects to be covered being: Traffic; Irrigation, Water Supply, and Sanitary Service; Roads and Bridges, Civil and Military Buildings, City Planning; Industry and Production of Energy; Mining Industry and Geology; Miscellaneous.

At the conclusion of the Congress there will be a sight-seeing excursion through Java, but the details for this trip have not as yet been arranged. Further information may be obtained by addressing The Secretary of the Executive Committee, General Engineering Congress, Molenvliet-Oost 3, Weltevreden (Java).

Dr. Mann's Report on Engineering Education

The report on Engineering Education, prepared by Dr. Charles R. Mann, under the auspices of the Carnegie Foundation for the Advancement of Teaching and the Joint Committee on Engineering Education of the National Engineering Societies, has been issued.

Any member of this Society may obtain a copy by writing to The Carnegie Foundation, Pittsburgh, Pa.

ANNOUNCEMENTS

The Reading Room of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, Fourth of July, Thanksgiving Day, and Christmas Day.

FUTURE MEETINGS

January 1st, 1919.—This meeting has been abandoned, by resolution of the Board of Direction, as it falls on New Year's Day.

ANNUAL MEETING

The Sixty-sixth Annual Meeting will be held at the Headquarters of the Society, 33 West 39th Street, New York City, on Wednesday and Thursday, January 15th and 16th, 1918.

COMMITTEE OF ARRANGEMENTS

W. W. BRUSH, *Chairman,*
F. S. CROWELL, J. DEB. W. GARDINER,
T. C. DESMOND, ALEX. HARING,
CHAS. WARREN HUNT.

The Business Meeting will be called to order at 10 o'clock on Wednesday morning. The Annual Reports will be presented, Officers for the ensuing year elected, members of the Nominating Committee appointed, Reports of Special Committees presented for discussion, and other business transacted.

SEARCHES IN THE LIBRARY

In January, 1902, the Secretary was authorized to make searches in the Library, upon request, and to charge therefor the actual cost to the Society for the extra work required. Since that time many searches have been made, and bibliographies and other information on special subjects furnished.

The resulting satisfaction to the members who have made use of the resources of the Society in this manner has been expressed frequently, and leaves little doubt that if it were generally known to engineers that such assistance could be had, many would avail themselves of it.

On October 1st, 1916, the Library of the American Society of Civil Engineers ceased to exist as such, and was merged in the Engineering Societies Library, adding 67 000 volumes to the collection, which comprises also the former libraries of the American Institute of Mining Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, and now has a total of 133 000 volumes and pamphlets. Containing, as the Library now does, the special collections mentioned, its scope is broadened, and, as it receives an unusually large number of technical periodicals, it is well equipped to continue the service formerly rendered by the Society Library.

The Engineering Societies Library offers this service at a cost which is trifling compared with the value of the time of an engineer who personally looks up such matters, and the work can be performed quite as well, and much more quickly, by persons familiar with the Library.

In asking that such work be undertaken, members should specify clearly the subject to be covered, and whether references to general books only are desired, or whether a complete bibliography, involving search through periodical literature, is desired.

It sometimes happens that references are found which are not readily accessible to the person for whom the search is made. In that case the Library is prepared to furnish photographic copies of the material at a small price per page. This method is particularly useful when there are drawings or figures in the text, which would be very expensive to reproduce by hand.

The Library is also able to provide translations of articles in foreign languages when desired.

Requests for searches, copies, translations, etc., should be addressed to the Director, Engineering Societies Library, 29 West 39th Street, New York City, who will gladly give information concerning the charges for the various kinds of service.

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association, Organized 1905.

Jerome Newman, President; Nathan A. Bowers, Secretary-Treasurer, 502 Rialto Building, San Francisco, Cal.

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet, and weekly informal luncheons. The former are held at 6 P. M., at the Engineers' Club, 57 Post Street, on the third Tuesday of February, April, June, August, October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at noon, every Wednesday, at the Engineers' Club, where special tables are reserved for members and guests of the Association.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest.

Colorado Association, Organized 1908.

L. R. Hinman, President; A. N. Miller, Secretary-Treasurer, 1400 West Colfax Avenue, Denver, Colo.

The meetings of the Colorado Association of Members of the American Society of Civil Engineers (Denver, Colo.) are held on the second Saturday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary. The meetings are usually preceded by an informal dinner. Members of the American Society of Civil Engineers will be welcomed at these meetings.

Weekly luncheons are held on Wednesday at 12.30 P. M., at Daniels and Fisher's.

Visiting members are urged to attend the meetings and luncheons.

(Abstract of Minutes of Meeting)

November 16th, 1918.—The meeting was called to order at the Savoy Hotel; President Hinman in the chair; A. N. Miller, Secretary; and present, also, 10 members and 3 guests.

The minutes of the Annual Meeting, held June 15th, and the special meeting, held July 27th, 1918, were read and approved.

The President outlined the methods used in selecting the programme committees.

On motion, duly seconded, the President was authorized to appoint a committee, of such number as he deems best, for the purpose of considering, in co-operation with the Colorado Society of Engineers, the bill for licensing civil engineers, which it is proposed to have introduced during the 1919 session of the State Legislature, and also for the purpose of keeping this Association advised of any other proposed legislation which may be of interest to the Engineering Profession.

It was suggested that one meeting be devoted to legislation.

On behalf of the University of Colorado, Professor Huntington thanked the Association for the invitation extended to the Junior and Senior engineering students to be present at this meeting, stating that, owing to the formality of leaving the organization known as the S. A. T. C., the students could not attend.

Mr. Charles W. Comstock addressed the meeting on the subject "The Modern Military Rifle", illustrating his remarks with lantern slides.

Adjourned.

Atlanta Association, Organized 1912.

B. M. Hall, President; Thomas P. Branch, Secretary-Treasurer, Georgia School of Technology, Atlanta, Ga.

Informal luncheons are held for members of the Association on the last Monday of each month, at 12.30 P. M. The place is not fixed, but this information will be furnished on application to the Secretary.

Baltimore Association, Organized 1914.

H. G. Perring, President; Charles J. Tilden, Secretary-Treasurer, The Johns Hopkins University, Baltimore, Md.

Cleveland Association, Organized 1914.

Harry Fuller, President; George H. Tinker, Secretary-Treasurer, 516 Columbia Building, Cleveland, Ohio.

Detroit Association, Organized 1916.

T. A. Leisen, President; Clarence W. Hubbell, Secretary, 2348 Penobscot Building, Detroit, Mich.

The regular meetings of the Association are held on the second Friday of December, April, and October, the last being the Annual Meeting.

District of Columbia Association, Organized 1916.

A. P. Davis, President; John C. Hoyt, Secretary-Treasurer, U. S. Geological Survey, Washington, D. C.

Duluth Association, Organized 1917.

W. B. Patton, President; Walter G. Zimmermann, Secretary, Wolvin Building, Duluth, Minn.

The regular meetings of the Association are held at noon on the third Monday of each month (usually at the Kitchi Gammi Club), with luncheon, followed by a short business session and the reading of papers. Visiting members of the American Society of Civil Engineers can secure from the Secretary definite information relative to the meetings, at which they will be welcomed. The Annual Meeting is held on the third Monday in May.

(Abstract of Minutes of Meetings)

October 26th, 1918.—The meeting was called to order in the evening; Second Vice-President Clark in the chair; Walter G. Zimmermann, Secretary; and present also 11 members.

A committee consisting of Messrs. Taylor, Dickerson, and Stack reported a set of resolutions on the death of Lieut. E. Porter Alexander, a charter member, who died in France on September 5th, 1918. These resolutions were adopted, and the Secretary was instructed to enter them in the minutes and send a copy to Mr. Alexander's family.

The death of First Vice-President Clarence Coleman was formally announced by the Chairman, and Messrs. Darling, Lewis, and McGilvray were appointed as a Committee on Resolutions.

Mr. W. H. Woodbury gave a short talk regarding members of the Association now in the United States War Service, and unfurled a service flag containing six stars for the following members:

Maj. E. K. Coe
Lieut. A. H. Ellison
Capt. E. W. Kelly
Lieut. E. P. Alexander (gold star)
Capt. C. D. Christie
Lieut. G. Bryan, Jr.

Mr. G. A. Taylor reported that he had received a letter from Maj. E. K. Coe, who is now in France.

There was a very interesting general discussion of matters which are likely to come up at the meeting of the Committee on Development, to be held at Chicago, Ill., on November 14th, 15th, and 16th, 1918.

The Secretary read an interesting letter from Lieut. George Bryan, Jr., at Camp Dodge, Iowa.

Adjourned.

November 18th, 1918.—The meeting was called to order; President Patton in the chair; Walter G. Zimmermann, Secretary; and present, also, 17 members and 1 guest.

Mr. W. H. Hoyt, the Association's representative on the Committee on Development, reported on the organization and work of that Committee at its recent meeting in Chicago.

Messrs. Darling, Lewis, and McGilvray reported the resolutions drawn up relative to the death of First Vice-President Clarence Coleman. On motion, duly seconded, the report was received and ordered entered in the minutes of the Association.

Mr. G. A. Taylor was elected as First Vice-President, to succeed Mr. Coleman.

The Secretary read a letter from Mr. Byron G. Best, of Ironwood, Mich., stating that he had entered the Field Artillery Central Officers Training School, at Camp Zachary Taylor, Ky. This increases the number of members of the Association in Army Service to 7.

Messrs. Darling and Ayres were requested to prepare memoirs of the late Clarence Coleman and E. P. Alexander, respectively, for publication by the Society.

The question of printing papers read before the Association was discussed, and the Committee on Records was asked to report, with recommendations, at the next meeting.

Adjourned.

Illinois Association, Organized 1916.

A. S. Baldwin, President; Edgar S. Nethercut, Secretary-Treasurer, 1735 Monadnock Blk., Chicago, Ill.

The regular meetings of the Association are held on the second Monday of March, June, September, and December, the last being the Annual Meeting. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary.

Louisiana Association, Organized 1914.

Arsene Perrilliat, President; Eugene F. Delery, Secretary, 2007 Laharpe St., New Orleans, La.

The regular meetings of the Association are held at The Cabildo, New Orleans, La., on the first Monday of January, April, July, and October.

Nebraska Association, Organized 1917.

George L. Campen, President; Homer V. Knouse, Secretary-Treasurer, 109 City Hall, Omaha, Nebr.

Regular meetings of the Association are held on the first Saturday of each month, except July and August, and at such places as may be appointed from time to time by the Executive Committee. The Annual Meeting is held in Lincoln, Nebr., on the second Friday in January.

An "Engineers' Round Table" is reserved daily for luncheon, at Courtenay's Restaurant, 17th and Douglas Streets, Omaha, to which all engineers are invited. Visiting members of the Society are especially urged to communicate with the Secretary when in the city.

Northwestern Association, Organized 1914.

Ralph D. Thomas, President; W. N. Jones, Secretary, City Engineer's Office, City Hall, Minneapolis, Minn.

The meetings of the Association are held bi-monthly, alternating between St. Paul and Minneapolis, on the third Friday of each month. Information as to the time and place of such meetings will be furnished on application to the Secretary.

Philadelphia Association, Organized 1913.

F. Herbert Snow, President; Henry T. Shelley, Secretary, 416 City Hall, Philadelphia, Pa.

The regular meetings of the Association are held at the Engineers' Club of Philadelphia, 1317 Spruce Street, on the first Monday in January, April, and October, the last being the Annual Meeting.

Pittsburgh Association, Organized 1917.

Richard Khuen, Jr., President; John D. Stevenson, Secretary-Treasurer, 1231 Monterey St., Pittsburgh, Pa.

The Annual Meeting of the Association is held on the first Monday in October. The time and place of other meetings are not fixed, but this information will be furnished on application to the Secretary.

Portland, Ore., Association, Organized 1913.

Philip H. Dater, President; C. P. Keyser, Secretary, 318 City Hall, Portland, Ore.

St. Louis Association, Organized 1888 (Constitution Approved by Board, 1914).

J. A. Ockerson, President; C. M. Daily, Secretary-Treasurer, 4240 Shaw Avenue, St. Louis, Mo.

The Annual Meeting of the Association for the election of officers and for the transaction of business, is held on the fourth Monday in November. Two meetings each year, for the presentation and discussion of technical papers, are held in the Auditorium of the Engineers Club of St. Louis and are open to members of the Associated Societies. Other "get-together" meetings are held regularly for dinner or luncheon on the fourth Monday of each month except July, August, and November.

San Diego Association, Organized 1915.

N. B. Kellogg, President; P. R. Watson, Secretary-Treasurer, *pro tem.,* County Engineer's Office, San Diego, Cal.

Seattle Association, Organized 1913.

A. S. Downey, President; Phil. A. Franklin, Secretary, 1409 East 65th St., Seattle, Wash.

The regular monthly meetings and luncheons of the Association are held at the Frye Hotel, 3d Avenue and Yesler Way, at 12.15 P. M., on the last Monday of each month. All members, in any grade, of the American Society of Civil Engineers are cordially invited to attend the meetings when in the vicinity.

(Abstract of Minutes of Meeting)

November 4th, 1918.—The meeting was called to order at 8:10 P. M., at the Engineers Club; President Downey in the chair; Phil. A. Franklin, Secretary; and present, also, 7 members.

The minutes of the meeting of October 28th, 1918, were read and approved.

The meeting was called for the purpose of hearing the report of the Committee on Relations to the Parent Society, and instructing Mr. John L. Hall, the Association's representative on the Development Committee, regarding the attitude of the Association toward the work of that committee.

Mr. A. H. Dimock, Chairman of the Committee on Relations to the Parent Society, presented the report of his committee. The ensuing discussion brought forth inquiries in regard to:

1.—The name to be used in designating the organizations now known as Local Associations;

2.—The manner of securing a fair representation for all concerned at the Annual Conventions;

3.—The probable function of the reorganized Society.

On the first point, opinion was about evenly divided between the names "Section" and "Chapter". The names "Association" and "Branch" were considered unsuitable for the reorganized body.

On the second point, the question was on the relative merits of representation on the basis of membership, that is, on the congressional plan, or on the basis of geographical (or other) division, namely, the senatorial plan. In the first case, the section of the country having the majority of members would be the controlling factor; in the second case, the section of the country having but few members would have a disproportionately large representation, but could not be overruled by another section of the country to its detriment. Other methods of securing representation were discussed, but no decision was reached.

In reference to the third question, Mr. Hall asked for an expression of opinion as to the function of the reorganized Society, whether it is to be of a technical nature, as in the past, or is to be broadened out into political, social, and other phases affecting more closely the individual in his daily life. This brought up the question of the advisability of all engineering societies uniting under one head, as opposed to the present system of each branch with its own organization, and one central body of delegates from the different branches. Nothing definite was decided. It was suggested that all the foregoing questions were subjects for consideration at the committee meeting at Chicago on November 14th, and that there would be sufficient time to consider them after hearing the ideas of the delegates at that meeting.

On motion, duly seconded, the report of the Committee on Relations to the Parent Society was adopted.

On motion, duly seconded, the following resolution was carried:

"It is the sense of this meeting that it is advisable for the American Society of Civil Engineers to invite the other National Engineering Societies to appoint similar Committees on Development with power to confer with our Committee."

Adjourned.

Southern California Association, Organized 1914.

Louis C. Hill, President; H. W. Dennis, Secretary, Edison Building, Los Angeles, Cal.

The Southern California Association of Members of the American Society of Civil Engineers (Los Angeles, Cal.) holds regular bi-monthly meetings, with banquet, at Hotel Clark, on the second Wednesday of February, April, June, August, October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at 12:15 P. M., every Thursday and the place of meeting may be ascertained from the Secretary.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in Los Angeles, and any such member will be gladly welcomed as a guest at any of the meetings or luncheons.

Spokane Association, Organized 1914.

Peter Mogensen, President; Charles E. Davis, Secretary, City Engineer's Office, Spokane, Wash.

The regular meetings of the Association are held on the second Friday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary.

Visiting members are invited to attend the meetings.

Texas Association, Organized 1913.

R. C. Gowdy, President; J. H. Brillhart, Secretary, Care, Mosher Mfg. Co., Dallas, Tex.

Utah Association, Organized 1916.

A. B. Villadsen, President, 304 Dooly Block, Salt Lake City, Utah.

The Annual Meeting of the Association is held on the first Wednesday in April. The time of other meetings is not fixed, but this information will be furnished on application to the President.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcomed by the following Engineering Societies, both to the use of their Reading Rooms, and at all meetings:

American Institute of Electrical Engineers, 25 West Thirty-ninth Street, New York City.

American Institute of Mining Engineers, 25 West Thirty-ninth Street, New York City.

American Society of Mechanical Engineers, 25 West Thirty-ninth Street, New York City.

Asociación de Ingenieros y Arquitectos de Mexico, Avenida Juarez, 12, City of Mexico, Mexico.

Assoçiacão dos Engenheiros Civis Portuguezes, Lisbon, Portugal.

Australasian Institute of Mining Engineers, Melbourne, Victoria, Australia.

Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass.

Brooklyn Engineers' Club, 117 Remsen Street, Brooklyn, N. Y.

Civil Engineers' Society of St. Paul, Public Library, St. Paul, Minn.

Cleveland Engineering Society, Chamber of Commerce Building, Cleveland, Ohio.

Cleveland Institute of Engineers, Middlesbrough, England.

Dansk Ingeniorforening, Amaliegade 38, Copenhagen, Denmark.

Detroit Engineering Society, Detroit Board of Commerce Building, Detroit, Mich.

Engineering Association of Nashville, Commercial Club Building, Nashville, Tenn.

Engineering Association of New South Wales, 5 Elizabeth Street, Sydney, New South Wales, Australia.

Engineering Institute of Canada, 176 Mansfield Street, Montreal, Que., Canada.

Engineering Societies Club of Hawaii, E. F. Cykler, Secretary, Honolulu, Hawaii.

Engineers and Architects Association of Southern California, 405 Hosfield Bldg., Los Angeles, Cal.

Engineers and Architects Club of Louisville, 1412 Starks Building, Louisville, Ky.

Engineers' Club of Baltimore, 6 West Eager Street, Baltimore, Md.

Engineers' Club of Kansas City, Robert S. Beard, Secretary, Third Floor, City Hall, Kansas City, Mo.

Engineers' Club of Minneapolis, 17 South Sixth Street, Minneapolis, Minn.

Engineers' Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa.

Engineers' Club of St. Louis, 3817 Olive Street, St. Louis, Mo.

Engineers' Club of Toronto, 96 King Street, West, Toronto, Ont., Canada.

Engineers' Club of Trenton, Trent Theatre Building, 12 North Warren Street, Trenton, N. J.

Engineers' Society of Northeastern Pennsylvania, 415 Washington Avenue, Scranton, Pa.

Engineers' Society of Pennsylvania, 31 South Front Street, Harrisburg, Pa.

Engineers' Society of Western Pennsylvania, 568 Union Arcade Building, Pittsburgh, Pa.

Florida Engineering Society, J. R. Benton, Secretary, Gainesville, Fla.

Institute of Marine Engineers, The Minories, Tower Hill, London, E., England.

Institution of Civil Engineers, Great George Street, Westminster, S. W., London, England.

Institution of Engineers of the River Plate, Calle 25 de Mayo 195, Buenos Aires, Argentine Republic.

Institution of Mechanical Engineers, 11 Great George Street, London, S. W. 1, England.

Institution of Naval Architects, 5 Adelphi Terrace, London, W. C., England.

Junior Institution of Engineers, 39 Victoria Street, Westminster, S. W., London, England.

Koninklijk Instituut van Ingenieurs, The Hague, The Netherlands.

Louisiana Engineering Society, State Museum Building, Chartres and St. Ann Streets, New Orleans, La.

Memphis Engineers' Club, Memphis, Tenn.

Midland Institute of Mining, Civil and Mechanical Engineers, Sheffield, England.

Montana Society of Engineers, Butte, Mont.

North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, England.

Oregon Society of Civil Engineers, Portland, Ore.

Pacific Northwest Society of Engineers, 803 Central Building, Seattle, Wash.

Rochester Engineering Society, Rochester, N. Y.

Sociedad Colombiana de Ingenieros, Bogota, Colombia.

Sociedad de Ingenieros del Peru, Lima, Peru.

Societe des Ingenieurs Civils de France, 19 rue Blanche, Paris, France.

Society of Engineers, 17 Victoria Street, Westminster, S. W., London, England.

Southwestern Society of Engineers, C. E. Barglebaugh, Secretary, 703 First National Bank Building, El Paso, Tex.

Svenska Teknologforeningen, Brunkebergstorg 18, Stockholm, Sweden.

Tekniske Forening, Vestre Boulevard 18-1, Copenhagen, Denmark.

Vermont Society of Engineers, George A. Reed, Secretary, Montpelier, Vt.

Western Society of Engineers, 1735 Monadnock Block, Chicago, Ill.

ACCESSIONS TO THE ENGINEERING SOCIETIES LIBRARY

(From November 1st to November 30th, 1918)

DONATIONS*

The statements made in these notices are taken from the books themselves, and this Society is not responsible for them.

SCREW PROPELLERS,

And Estimation of Power for Propulsion of Ships; Also Air-Ship Propellers. By Rear-Admiral Charles W. Dyson, U. S. N. 2d edition, rewritten. N. Y., John Wiley and Sons, Inc.; Lond., Chapman and Hall, Ltd., 1918. 325 pp., 62 illus., 32 pl., 18 tab., 2 vol. (text and atlas), cloth. $7.50.

The first edition of this work on propeller design suffered, the author states, from two serious faults, one being the vagueness of the method for determining the thrust deduction factor and the other the method of applying it in determining the characteristics of the propeller. Both have been eliminated to a great degree in this edition, and other improvements have been introduced in the text. The author's ideas on cavitation are now fully presented. A chapter on airplane propeller design has been added.

AUTOMOTIVE MAGNETO IGNITION;

Its Principle and Application, with Special Reference to Aviation Engines. By Mich. E. Toepel. N. Y., Spon and Chamberlain; Lond., E. & F. N. Spon, Ltd., 1918. 103 pp., illus., charts, diags., 8 x 4 in., cloth. $2.00.

The subject is presented herein in the form of questions and answers covering the general principles of magneto ignition. References to specific types of apparatus have been avoided. Numerous illustrations and wiring diagrams are included.

AERO ENGINES, MAGNETOS, AND CARBURETORS.

By Harold Pollard. N. Y., The Macmillan Co., 1918. 84 pp., 15 illus., 15 pl., 6 x 4 in., cloth. $1.00.

A brief manual, written in simple language and intended for beginners, which makes no pretense to be an exhaustive technical treatment of its subject.

CENTRAL STATION HEATING.

By Byron T. Gifford. 2d edition. N. Y., Heating and Ventilating Magazine Company, 1918. 278 pp., 34 illus., tab., 9 x 6 in., cloth. $3.00.

Particular attention has been directed in this edition to the regulations adopted by the various State Governments for the control of public utilities, especially to the methods of cost accounting necessitated by rate and valuation investigations. The discussion of high-pressure steam distribution has been expanded, and the entire book has been revised.

ELECTRIC WELDING:

A Comprehensive Treatise on the Practice of the Various Resistance and Arc Welding Processes, Covering Descriptions of the Machines and Apparatus Used and the Applications, Both in Manufacturing and Repair Work. By Douglas T. Hamilton and Erik Oberg. N. Y., The Industrial Press, 1918. 294 pp., 217 illus., 2 tab., 9 x 6 in., cloth. $2.50.

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*Unless otherwise specified, books in this list have been donated by the publishers.

This book, it is stated, is a summary of present practice. The authors announce that they have had the assistance of the most prominent American firms engaged in this work, and that they have thus been able to present information on the latest improvements and discoveries.

COAL AND ITS SCIENTIFIC USES.

By William A. Bone. (Monographs on Industrial Chemistry.) Lond. and N. Y., Longmans, Green and Co., 1918. 15 + 491 pp., illus., pl., charts, diags., tab., 9 x 6 in., cloth. $7.00.

The author, who was Chairman of the British Association Fuel Economy Committee in 1915–17, has tried to give, in essential outline, an account of the present state of science and practice in relation to coal and its various uses. Beginning with an account of the general and scientific aspects of the coal question from a British point of view, there follows a review of the present state of science regarding the origin and chemistry of coal, including its distillation, oxidation, and combustion. In the latter part of the book the principal economic and industrial uses of coal as a fuel are considered, and it closes with an account of surface combustion. The monograph is intended to provide a succinct account of the statistical, chemical, and technical aspects of the subject as a whole, without unnecessary detail, for use by the scientific public, especially by chemists.

THE J. E. ALDRED LECTURES ON ENGINEERING PRACTICE, 1917-18.

The Johns Hopkins University, Department of Engineering. Baltimore, The Johns Hopkins Press, 1918. 263 pp., illus., 2 folded pl., 1 map, 9 x 6 in., paper. (Gift from The Johns Hopkins University.)

In these lectures is given a presentation of the tangible and obvious features and principles of present engineering practice, by which it is intended to instruct the undergraduate students of the University in every-day working methods of design, construction, and operation. Contents: Steam-Electric Power Plant Design; The Relation Between Civil Engineering and Military Engineering; The Development of Concrete Road Construction; Copper Refining; The Coal Problem; The Growth of Electric Systems; The Operation of a Manufacturing Plant; The Control of Stream Pollution; The Manufacture of Structural Steel.

ENGINEERING DIRECTORY;

Buyers' Reference Section, 1918 Edition; A Comprehensive Directory of Manufacturers of Mill, Steam, Mine, Plumbing, Heating and Lighting Supplies, Machinery and Tools. Chicago, The Crawford Publishing Co. (copyright 1918). 566 pp., 11 x 8 in., cloth.

This volume contains a list of American manufacturers, trade names, and brands of industrial and engineering supplies and machinery, arranged under approximately 4 000 subject headings, and a directory of manufacturers. An extensive cross-index to the classification is provided.

DAVISON'S TEXTILE "BLUE BOOK", UNITED STATES AND CANADA:

Cotton, Woolen, Silk, Jute, Flax and Linen Manufacturers; Dyers, Bleachers and Print Works; Commission Merchants; Converters and Brokers; Yarn, Cotton, Waste, Linter Dealers; Mattress Manufacturers; Wool, Rag and Mill Remnant Dealers; Raw, Thrown and Spun Silk Dealers, etc. With a Full Classified Directory of Cotton and Woolen Mills and a Textile Supply Directory. 31st Annual Edition, July, 1918, to July, 1919. N. Y., Davison Publishing Co. (copyright 1918). 1471 pp., 7 maps, 9 x 7 in., cloth. $5.00.

This directory covers the textile manufacturers, dyers, bleachers, printers, commission merchants, dealers, and makers of textile mill supplies in the United States and Canada. The various lists are carefully classified for quick reference. The capitalization, officers, equipment, products, and railroad connections of each mill are given. Maps showing the location of the textile mills of the country are included.

THE RESULT OF MUNICIPAL ELECTRIC LIGHTING IN MASSACHUSETTS.

By Edmond Earle Lincoln. (Hart, Schaffner and Marx Prize Essays, No. 27.) Bost. and N. Y., Houghton Mifflin Co., 1918. 20 + 484 pp., 14 charts, 1 map, 58 tab., 8 x 5 in., cloth. $3.00.

As a contribution to the discussion on the advantages and disadvantages of public ownership, the author has prepared this impartial, comparative study of results in one well-established business in a specific locality where adequate records covering a period of years can be secured. The aim of the book is to suggest and exemplify those methods of approach and investigation, which may most profitably be followed in future studies of the problems of municipal and State ownership. It is based on a careful, personal statistical study of the annual returns made by the plants to the Massachusetts Board of Gas and Electric Commissioners and a personal survey of the plants themselves.

THEORY OF STRUCTURES.

By Arthur Morley. New Edition. Lond. and N. Y., Longmans, Green and Co., 1918. 11 + 584 pp., 319 illus., 4 pl., tab., 9 x 6 in., cloth. $4.50.

The author sets forth the theory of the simpler structures so far as it relates to strength, stiffness, and stability. In order to present the subject completely, he has included in the earlier chapters considerable matter dealing with the theory of strains and stresses in single pieces, practically as it appeared in his "Strength of Materials". The discussion is confined to wooden and metallic structures, reinforced concrete being omitted. Worked-out examples form a feature of the text.

STRUCTURAL SERVICE BOOK, VOL. I:

A Revised Reprint from the Twelve Issues for 1917 of *The Journal* of the American Institute of Architects Structural Service Department. D. Knickerbacker Boyd, Editor. Wash., The Journal of the American Institute of Architects, 1918. 16 + 226 pp., Including Industrial Section, 12 x 9 in., cloth. $3.50.

The first volume of an annual review of structural activities throughout the United States with particular reference to the standards adopted or under consideration by the various societies, associations, or other agencies whose work concerns itself in any way with the materials which enter into building construction, the methods and safety of their production, manufacture, and erection. The material is classified and indexed for ready reference. Under each heading are given lists of references to publications giving general information, describing recommended practice, and adopted standards.

PRACTICAL SURVEYING AND FIELD WORK:

Including the Mechanical Forms of Office Calculations, with Examples Completely Worked Out. By Victor G. Salmon. Lond., Charles Griffin & Co., Ltd.; Phila., J. B. Lippincott Co., 1918. 204 pp., 87 illus., 3 folded diag., 8 x 5 in., cloth. (Gift from J. B. Lippincott Co.)

The author has endeavored to supply to students a series of calculations which, in connection with well-known textbooks, will equip the young surveyor for the practice of the profession. The work consists mainly of solutions to questions set in examinations for qualification as surveyors in the South African Colonies. It is not intended as a textbook, and includes only so much theory as is necessary to explain the examples.

MAP READING AND TOPOGRAPHICAL SKETCHING.

By Edwin R. Stuart. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1918. 11 + 139 pp., 46 illus., 1 map, 8 x 5 in., cloth. $1.00.

This textbook represents the results of the author's thirteen years of experience in the practice and teaching of topographic surveying and sketching at the United States Military Academy.

CONVEYANCE AND DISTRIBUTION OF WATER FOR WATER SUPPLY:

Aqueducts, Pipe-Lines and Distributing Systems; A Practical Treatise for Water-Works Engineers and Superintendents. By Edward Wegmann. N. Y., D. Van Nostrand Co., 1918. 663 pp., 367 illus., 8 pl., 9 x 6 in., cloth. $5.00. (Gift from Author.)

By restricting himself to the conveyance and distribution of water, the author has been able, within the limits of a single volume, to discuss the subject in sufficient detail to make this work of practical value to engineers and superintendents of water-works. Beginning with a chapter on the consumption of water, the flow of water in aqueducts and pipes is next discussed. Then follow chapters on the design and construction of pipes, aqueducts, service reservoirs, stand-pipes and tanks, fire protection and high pressure systems. The remaining chapters take up maintenance and operation, the cleaning of aqueducts and mains, thawing frozen pipes, leakage, electrolysis, pipe tools, and the detection and prevention of water waste.

SUMMARY OF SOCIETY MEMBERSHIP SERVING IN THE ARMIES AND NAVIES OF THE UNITED STATES AND ITS ALLIES

December 12th, 1918

American Army

Major-Generals	10
Brig.-Generals	15
Colonels	48
Lt.-Colonels	59
Majors	242
Captains	563
First Lieutenants	288
Second Lieutenants	83
Regimental Sergeants	1
Master Engineers	7
Master Gunners	2
Sergeants	15
Corporals	6
Privates	48
Students, Training Camps	13
Miscellaneous	4
Total	1404

British Army

Brig.-Generals	1
Lt.-Colonels	5
Majors	10
Captains	16
Lieutenants	17
Second Lieutenants	6
Corporals	2
Privates	1
Miscellaneous	1
Total	59

French Army

Commandant (rank not given)	1
Captains	2
Sous-Lieutenant	1
Aspirant	1
Miscellaneous	2
Total	7

Italian Army

Colonel	1
Total in Armies	1471

Summary for Armies

Major-Generals	10
Brig.-Generals	16
Colonels	49
Lt.-Colonels	64
Majors	252
Commandant (rank not given)	1
Captains	581
Lieutenants	305
Second Lieutenants	90
Regimental Sergeants	1
Master Engineers	7
Master Gunners	2
Sergeants	15
Corporals	8
Privates	49
Students, Training Camps	14
Miscellaneous	7
Total	1471

American Navy

Rear-Admirals	5
Captains	5
Commanders	12
Lt.-Commanders	14
Civil Engineers (rank not given)	12
Lieutenants	29
Lieutenants (Junior Grade)	9
Ensigns	12
Asst. Paymaster (rank not given)	1
Chf. Machinist's Mate	3
Chf. Carpenter's Mate	1
Marine	1
Miscellaneous	1
Total	105

British Navy

Lieutenant	1
Total in Navies	106

Summary for Navies

Rear-Admirals	5
Captains	5
Commanders	12
Lt.-Commanders	14
Civil Engineers (rank not given)	12
Lieutenants	30
Lieutenants (Junior Grade)	9
Ensigns	12
Asst. Paymaster (rank not given)	1
Chf. Carpenter's Mate	1
Chf. Machinist's Mate	3
Marine	1
Miscellaneous	1
Total	106

RECAPITULATION

Total in Army	1471	
Total in Navy	106	
Total on Roll of Honor		1577
Died in Service		16
Grand Total		1593

ROLL OF HONOR

A List of Members of the Society Who are Serving in the Army or Navy of the United States or Any of Its Allies.*

VANSITTART, GEORGE EDWARD. *Maj., 13th Battery, Canadian Field Artillery, 2d Canadian Div.; wounded in action (France); died May 14th, 1916.*

AGNEW, AUGUSTUS WATEROUS. *Capt., 3d Canadian Pioneers; wounded in action (France); died September 17th, 1916.*

HAGUE, WILLIAM. *1st Lieut., Engr. R. C., 116th Engrs.; died in service (France), January 1st, 1918.*

GOODFELLOW, JAMES GORDON. *Maj., Royal Engrs.; killed in action (France), March 23d, 1918.*

BUCKWALTER, HARRIS DANIEL. *Capt., Engr. R. C.; killed in action (France), May 12th, 1918.*

LINDBERY, CHARLES ARTHUR. *Capt., Engr. R. C.; died in service (Camp Lee, Va.), May 27th, 1918.*

ANNEAR, EDGAR HAROLD. *Capt., Engr. R. C.; died in service (Hoboken, N. J.), August 28th, 1918.*

SLEPPY, KIRBY BALDWIN. *Capt., Engineers, U. S. A., 4th Engrs.; killed in action (France).*

ALEXANDER, EDWARD PORTER. *1st Lieut., Engineers, U. S. A., 509th Engrs.; died in service (France), September 5th, 1918.*

McCLURE, HUNTER. *1st Lieut., Engineers, U. S. A., Co. N, 21st Engrs.; died in service (France), September 26th, 1918.*

REAM, WARD HALL. *1st Lieut., Engineers, U. S. A., Co. C, 305th Engrs.; killed in action (France), October 4th, 1918.*

DEDICKE, ERNEST CHARLES. *1st Lieut., U. S. A.; wounded in action (France); died July 15th, 1918.*

DEAN, STANLEY. *Capt., Quartermaster Corps, U. S. A.; died in service (Camp Humphreys, Va.), October 2d, 1918.*

PECK, MYRON HALL. *Capt., Engineers, U. S. A., 2d Engrs.; killed in action (France), October 9th, 1918.*

HONEYMAN, BRUCE RITCHIE. *Capt., Engineers, U. S. A., Co. A, 313th Engrs.; died in service (France), October 15th, 1918.*

MILLS, ADELBERT PHILO. *Capt., Engineers, U. S. A.; died in service (France), October 20th, 1918.*

Abbot, Frederic V. Brig.-Gen., Engineers, U. S. A.

Abbot, Frederick William. Lt.-Col., British Army.

Acher, A. H. Maj., Engineers, U. S. A.; Acting Lt.-Col., 4th Engrs., A. E. F., France.

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* This list is made up from replies to a circular forwarded to members of the Society, and others, and is probably neither accurate nor complete. It is requested that the attention of the Secretary be called to any omissions or inaccuracies in order that they may be corrected in subsequent lists.

Acker, Robert L. Corporal, Headquarters Co., 7th F. A., A. E. F., France.

Ackerman, Alexander S. Capt., Engineers, U. S. A., A. E. F., France.

Ackerman, Arthur P. 1st Lieut., Engineers, U. S. A., 517th Engrs.

Adams, Arthur. Lt.-Col., Ordnance, U. S. A.

Adams, Edward M. Maj., U. S. A.

Adams, Milton Jewell. Capt., Engineers, U. S. A., Co. C, 114th Engrs.

Adams, Raymond E. Capt., Quartermaster Corps, U. S. A.

Adams, Walter Francis. Sergeant, Co. E, 2d Bn., 23d Engrs., A. E. F., France.

Adams, William H. Capt., Quartermaster Corps, U. S. A.

Albert, Frederick W. Lt.-Col., Engineers, U. S. A., 33d Engrs.

Alden, Herbert C. 1st Lieut., Coast Artillery, U. S. A.

Alden, Langford Taylor. Aspirant, 7e Batterie, 51st Regt. d'Artillerie, Secteur Postal No. 82 (French Army); Care, Morgan, Harjes Cie., Boulevard Haussmann, Paris, France.

Alderman, Ernest S. 2d Lieut., Quartermaster Corps, U. S. A.

Alexander, Kay. Maj., 2d in Command, 12th Canadian Ry. Troops, B. E. F., France.

Allen, Franklin R. Capt., Engineers, U. S. A.

Allen, Herschel Heathcote. Capt., Engineers, U. S. A.

Allen, Ralph B. 1st Lieut., Engineers, U S. A., Co. B, 25th Engrs., A. E. F., France.

Allen, Walter Henry. Maj., Engineers, U. S. A.

Allen, Walter Hinds. Commander, Civil Engineer Corps, U. S. N.

Allison, L. M. 2d Lieut., Infantry, U. S. A., Co. E, 2d Inf. Replacement Regt.

Allison, William F. Maj., Engineers, U. S. A., A. E. F., France.

Altman, Frank S. Lieut., Engineers, U. S. A., 23d Engrs.

Altstaetter, F. W. Col., Engineers, U. S. A.

Anders, Frank L. Capt., Quartermaster Corps, U. S. A.

Anderson, C. L. B. Lieut., Civil Engineer Corps, U. S. N.

Anderson, J. E. Maj., 212th Field Co., Royal Engrs., B. E. F., France.

Anderson, J. H. Capt., Engineers, U. S. A.; Adjt., 1st Replacement Engrs.

Anderson, W. P. Capt., Engineers, U. S. A., A. E. F., France.

Anderson, W. S. Cadet, School of Military Aeronautics, U. S. A.

Andrew, Clarence R. Capt., Engineers, U. S. A., 32d Engrs.

Andrews, Carl B. Capt., Engineers, U. S. A.

Andrews, J. H. M. Lt.-Col., Ordnance, U. S. A.

Angas, Robert M. 1st Lieut., U. S. A., 106th Engrs.

Applegarth, Gault. Capt., Engineers, U. S. A., 23d Engrs.

Ardery, Edward Dahl. Col., Engineers, U. S. A.

Armitage, George W. Maj., Quartermaster Corps, U. S. A.

Arms, Leo M. Lieut., Engineers, U. S. A., Co. F, 2d Engrs., A. E. F., France.

Armstrong, Charles Johnstone. Brig.-Gen.; Chf. Engr., H. Q., Canadian Army Corps, B. E. F., France.

Armstrong, Harry A. 6th Co., E. O. T. C., Camp A. A. Humphreys, Va.

Armstrong, Merwin. Capt., Engineers, U. S. A., Co. D, 105th Engrs., A. E. F., France.

Armstrong, Roger W. Capt., Quartermaster Corps, U. S. A.

Arn, William G. Maj., Engineers, U. S. A., 13th Engrs. (Ry.), Postal Sector 215, A. E. F., France.

Arnold, Bion J. Lt.-Col., Air Service, U. S. A.

Ashkins, Nathan Thomas. 1st Lieut., Engineers, U. S. A., Lines of Communication, Eng. Headquarters, A. E. F., France.

Ashley, Carl. Capt., Engineers, U. S. A., U. S. M. P. O. 702, A. E. F., France.

Ashmead, P. H. Maj., Engineers, U. S. A.

Ashton, Raymond. 2d Lieut., Air Service, U. S. A., A. E. F., France.

Ashworth, Frank Karr. 1st Lieut., Engineers, U. S. A.

Asplundh, E. T. Capt., Engineers, U. S. A.; Supply Officer, 103d Engrs.

Asserson, Henry Raymond. Maj., Engineers, U. S. A., C. E. L. O. C., A. E. F., France.

Atterbury, W. W. Brig.-Gen.; Director-General of Transportation, A. E. F., France.

Atwood, William G. Lt.-Col., Engineers, U. S. A., 17th Engrs. (Ry.), U. S. A. P. O. 701, A. E. F., St. Nazaire, France.

Austill, Hurieosco. Capt., Engineers, U. S. A., Co. D, 501st Engrs. (Service Bn.), A. E. F., France.

Austin, H. A. R. 1st Lieut., Engineers, U. S. A.

Ayres, John Henry. Capt., Engineers, U. S. A., Co. D, 42d Engrs.

Ayres, Quincy C. 2d Lieut., Engineers, U. S. A. (*Unattached*), A. E. F., France.

Babbitt, Harold E. Capt., Engineers, U. S. A., U. S. P. O. No. 757, A. E. F., France.

Baffrey, Charles R. Capt., 102d Reg. d'Artillerie (French Army), Secteur Postal 160, B. C. M., Paris, France.

Bailey, Lewis P. Capt., Engineers, U. S. A., Co. A, 304th Engrs.

Bakenhus, R. E. Commander, Civil Engineer Corps, U. S. N.

Baker, George L. Capt., U. S. A., Co. C, 13th Bn., U. S. Guards.

Baker, H. S. Lt.-Col., Engineers, U. S. A., 111th Engrs.

Baker, Shirley. Capt., Engineers, U. S. A., Co. B, 23d Engrs.

Balch, William H. Maj., Engineers, U. S. A., A. P. O. 717, A. E. F., France.

Barber, Charles W. Private, 38th Engrs.

Barber, Justin F. Sergeant, Co. M, 23d Engrs., A. E. F., France.

Barber, Norman N. Capt., Engineers, U. S. A., 16th Engrs., A. E. F., France.

Barclay, A. J. 1st Lieut., Engineers, U. S. A.

Barnard, Archer F. 1st Lieut., Engineers, U. S. A.

Barney, Samuel E. Maj., Engineers, U. S. A. (*Unassigned*).

Barry, E. J. Maj., Engineers, U. S. A.

Bartholomew, B. W. Lieut., Engineers, U. S. A., 301st Engrs.

Bascom, George R. Maj., Sanitary Corps, U. S. A.

Bass, Fred T. Capt., Engineers, U. S. A., Headquarters, 1st Bn., 32d Engrs., A. E. F., France.

Bassett, Herbert H. Maj., Engineers, U. S. A.

Battie, H. S. 1st Lieut., Engineers, U. S. A.

Baxter, O. G. Capt., Engineers, U. S. A., Co. C, 601st Engrs.

Bayliss, Paul. 2d Lieut., Engineers, U. S. A., 8th Engrs. (Mounted).

Beach, Lansing H. Col., Engineers, U. S. A.

Beale, Allan S. Lieut., U. S. Air Service (Aeronautics).

Beall, Pendleton. Private, Headquarters Co., 165th Inf., A. E. F., France.

Beam, Carl Eugene. 2d Lieut., Engineers, U. S. A.

Bean, Paul Jones. Civ. Engr., U. S. N.

Bebb, Edward C. Capt., Engineers, U. S. A.

Beck, Edward A. Capt., Sanitary Corps, U. S. A.

Bee, Charles E. 1st Lieut., Engineers, U. S. A.

Beebe, James W. Capt., Engineers, U. S. A.

Beeman, Thomas R. Capt., Engineers, U. S. A., Care, D. G. T., A. E. F., France.

Beerbower, Dumont. Capt., Engineers, U. S. A., Co. C, 535th Engrs.

Begg, R. B. H. Capt., Engineers, U. S. A., A. E. F., France.

Behrman, I. E. 1st Lieut., Engineers, U. S. A., Care, C. E. O., Zone of the Advance, A. E. F., France.

Bell, George Edward. Lieut., Canadian Engrs., Care, Bank of Montreal, Waterloo Pl., London, S. W. 1, England.

Bell, Harry W. Capt., Engineers, U. S. A., 5th Bn., 22d Engrs., A. E. F., France.

Bellinger, L. F. Commander, Civil Engineer Corps, U. S. N.

Benham, Claude Gilbert. Capt., Coast Artillery, U. S. A.

Benham, W. L. Maj., Quartermaster Corps, U. S. A.

Bennett, John W. F. Maj., Quartermaster Corps, U. S. A., Constr. Div.

Bennison, Ernest William. 1st Lieut., Engineers, U. S. A., 23d Engrs.

Bensel, J. A. Maj., Engineers, U. S. A.

Benson, Orville. Maj., Engineers, U. S. A., A. E. F., France.

Berdeau, Ray W. Capt., Engineers, U. S. A.; Engr. Officer, 220th Engrs.

Bergan, Thomas B. Lieut., U. S. A.

Best, Byron G. Private, Field Artillery Central Officers' Training Camp, Camp Zachary Taylor, Ky.

Betts, Clifford A. 1st Lieut., Coast Artillery, U. S. A., Battery E, 52d Artillery, A. E. F., France.

Bickel, George R. Chf. Machinist's Mate, U. S. N. R. F.

Biddle, John. Maj.-Gen., U. S. A.

Billings, A. W. K. Lt.-Commander, Civil Engineer Corps, U. S. N. R. F., U. S. Naval Headquarters, 30 Grosvenor Gardens, S. W., London, England.

Billings, Fred M. Capt., Engineers, U. S. A.

Binckley, George Sydney. Maj., Engineers, U. S. A., 112th Engrs.

Binger, Walter D. 2d Lieut., Signal Corps, U. S. A.

Birdseye, Claude H. Maj., Engineers, U. S. A., Office, Chf. of Artillery, A. P. O. 706, A. E. F., France.

Bishop, Roy P. 2d Lieut., Engineers, U. S. A., 35th Engrs., A. P. O. 735, A. E. F., France.

Bissell, C. T. Capt., Quartermaster Corps, U. S. A.

Bither, T. A. 2d Lieut., Signal Corps, Aviation Section, U. S. A.

Bixby, William H. Brig.-Gen., U. S. A. (*Retired*).

Black, Dudley F. Capt., Engineers, U. S. A., Co. C, 513th Engrs., A. E. F., France.

Black, E. B. Maj., A. S. (P.), U. S. A.

Black, G. G. Capt., Engineers, U. S. A.; Acting Adjt., 314th Engrs.

Black, James B. Capt., Engineers, U. S. A., Office, D. M. E. and E. S., A. P. O. 717, A. E. F., France.

Black, Ralph P. 1st Lieut., Engineers, U. S. A., 32d Engrs.

Black, Roger Derby. Lt.-Col., Engineers, U. S. A., Headquarters, A. E. F., France.

Black, Walter G. 1st Lieut., Co. 7, E. O. T. S., Camp A. A. Humphreys, Va.

Black, William M. Maj.-Gen., U. S. A.; Chf. of Engrs., U. S. A.

Blackman, J. W. B. Lieut., Canadian Ry. Troops, C. E. F., France.

Blair, Alexander. 2d Lieut., Royal Engrs., B. E. F., France.

Blair, McCrea Parker. Capt., No. 1 Depot Bn., Manitoba Regt., Winnipeg, Man., Canada.

Blanchard, Murray. Maj., Engineers, U. S. A., 520th Engrs.

Blauvelt, Louis D. Maj., Quartermaster Corps, U. S. A.

Boesch, Clarence E. Capt., U. S. A., Co. B, 105th Engrs.

Boggs, F. C. Col., U. S. A., 315th Engrs.

Boland, Charles J. 1st Lieut., Signal Corps, U. S. A., 492d Constr. Div., A. E. F., France.

Bolger, Edwin Gibson. Barron Field, Everman, Tex.

Bolin, Harry W. Sergeant, Co. E, 23d Engrs.

Bolton, Frank L. Capt., Engineers, U. S. A.

Bond, P. S. Col., U. S. A., 107th Engrs.; Div. Engr., 32d Div., Army Engr. School, U. S. P. O. 714, A. E. F., France.

Bonner, John P. Capt., Coast Artillery, U. S. A., A. E. F., France.

Boorman, Kitchell M. Lieut., U. S. A., Office, Chf. Engr., 2d Army, A. P. O. 784, A. E. F., France.

Booth, Raymond. 1st Lieut., Engineers, U. S. A., 54th Engrs.

Booz, Horace Corey. Col., Railroad Transportation Corps, U. S. A., Care, D. G. T., A. E. F., France.

Borchers, Perry E. Capt., Engineers, U. S. A.

Borden, Guy. Co. 1, 5th Engr. Tr. Regt., Camp Humphreys, Va.

Boschke, Guy. Maj., Engineers, U. S. A., M. P. O. 705, A. E. F., France.

Bott, C. N. 1st Lieut., Engineers, U. S. A., 312th Engrs.

Boult, Charles N. 2d Lieut., 28th Reinforcements, New Zealand Engrs., N. Z. E. F., Care, P. O., Wellington, New Zealand.

Bowen, Charles K. Capt., Engineers, U. S. A.

Bowen, Edward Withers. Capt., Infantry, U. S. A., 2d Inf. Replacement Regt.

Bowie, William. Maj., Engineers, U. S. A.

Bowlby, Henry L. Maj., U. S. A., 43d Engrs.

Bowles, James T.-B. Maj., Sanitary Corps, U. S. A.

Bowne, Sidney B. 2d Lieut., U. S. Public Health Service.

Boyd, George R. Capt., Engineers, U. S. A., A. E. F., France.

Boyden, Harry C. Maj., Engineers, U. S. A.

Boyle, James M. Maj., Ordnance, U. S. A.

Brace, James H. Maj., U. S. A., 22d Engrs., A. E. F., France.

Bragg, Kendal B. Lieut., Civil Engineer Corps, U. S. N.

Braly, Raymond F. 1st Lieut., Engineers, U. S. A.

Braunworth, Percy L. Capt., Engineers, U. S. A., Care, Director-General of Transportation, Army P. O. 705, A. E. F., France.

Bres, Edward Sedley. 1st Lieut., Engineers, U. S. A., 114th Engrs.

Breuchaud, Jules R. Capt., Quartermaster Corps, U. S. A., Constr. Div.

Brewster, Henry B. Capt., Engineers, U. S. A., and Adjt., 303d Engrs.

Breymann, John B., Jr. 2d Lieut., Coast Artillery, U. S. A., 22d Co.

Briggs, Robert W. 2d Lieut., Signal Corps, Aviation Section, U. S. A., 73d Aero Constr. Squadron.

Bright, Graham B. Capt., Engineers, U. S. A., and Regimental Adjt., 305th Engrs. (Pioneers).

Brinkley, Milo H. Capt., Engineers, U. S. A.

Bronson, Howard F. Capt., Sanitary Corps, U. S. A.

Brook, A. E. Capt., Royal Engrs., B. E. F., France.

Brooking, J. H. Capt., Engineers, U. S. A., Co. B, 12th Engrs. (Ry.), A. E. F., France.

Brooks, Josiah R. 1st Lieut., Engineers, U. S. A.

Brown, Charles E. Capt., Engineers, U. S. A.

Brown, Clarence C. 1st Lieut., Co. E, 12th Engrs. (Ry.), A. E. F., France.

Brown, Earl I. Col., U. S. A., 317th Engrs.

Brown, Elbert C. Capt., Engineers, U. S. A., 142d Engrs.

Brown, Elliot C. Lt.-Commander, U. S. N. R. F.

Brown, H. Whittemore. 2d Lieut., Engineers, U. S. A., A. E. F., France.

Brown, Harry Madara. 1st Lieut., Air Service, U. S. A.

Brown, Levant R. Capt., Engineers, U. S. A.

Brown, Marshall W. Maj., Engineers, U. S. A., P. O. 702, A. E. F., France.

Brown, Norman F. Maj., Railroad Transportation Corps, U. S. A., Care, Director-Gen. of Transportation, A. E. F., France.

Brown, Robert H. Maj., Sanitary Corps, U. S. A.

Brownell, E. H. Commander, Civil Engineer Corps, U. S. N.

Bruner, Louis S. 1st Lieut., U. S. A., Co. I, 23d Engrs., A. E. F., France.

Brush, Carl F. Capt., Engineers, U. S. A., A. P. O. 716, A. E. F., France.

Bruton, Philip G. 2d Lieut., Constr. Div., Aviation Section, Signal Corps, U. S. A.

Bryan, Clark A. Capt., Engineers, U. S. A.

Bryan, George, Jr. 1st Lieut., Engineers, U. S. A.

Buchanan, Warren Henderson. Chf. Machinist Mate, U. S. N. R. F.

Bucher, Harold F. Lieut., Engineers, U. S. A., 2d Engrs., A. E. F., France.

Buck, Richard S. Maj., 11th Engrs. (Ry.), A. E. F., France.

Buck, Walter Van. Capt., Engineers, U. S. A., 23d Engrs.

Bull, George M. Civ. Engr., U. S. N. R. F.

Bunker, George H. Capt., Engineers, U. S. A., 306th Engrs.

Bunker, Stephen S. Capt., Engineers, U. S. A., Co. C, 503d Service Bn., A. E. F., France.

Burd, Edward M. Capt., Coast Artillery, U. S. A.

Burdett, O. L. Capt., Engineers, U. S. A., Co. A, 25th Engrs., A. E. F., France.

Burger, Alfred A. 2d Lieut., Infantry, U. S. A., 19th Co., 2d Inf. Replacement Regt.

Burgess, Harry. Col., U. S. A., 16th Engrs. (Ry.), A. E. F., France.

Burkett, Joseph M. Capt., Engineers, U. S. A., A. E. F., France.

Burky, C. R. Capt., Signal Corps, Aviation Section, U. S. A.

Burr, Edward. Col., Engineers, U. S. A., Manila, Philippine Islands.

Burrell, Glenn S. Lt.-Commander, Civil Engineer Corps, U. S. N.

Burrowes, H. G. 1st Lieut., Engineers, U. S. A., Co. B, 25th Engrs., A. E. F., France.

Burt, Henry J. Maj., Quartermaster Corps, U. S. A.

Burton, William. 1st Lieut., Engineers, U. S. A.

Bush, Lee M. 2d Lieut., Field Artillery, U. S. A.

Bush, Lincoln. Col., Quartermaster Corps, U. S. A.

Bushnell, Howard B. Capt., Engineers, U. S. A., A. E. F., France.

Bushnell, Howard E. Capt., Engineers, U. S. A.

Busse, Franz A. Capt., Engineers, U. S. A. (*Unattached*), A. E. F., France.

Butler, John Soule. Lt.-Col., Engineers, U. S. A.

Butler, Millard A. Col., Quartermaster Corps, U. S. A.

Butler, William P. Lieut., U. S. N. R. F.

Byam, L. H. Capt., Engineers, U. S. A.

Byllesby, Henry M. Maj., Signal Corps, Aviation Section, U. S. A.

Byrd, J. H. Capt., Engineers, U. S. A., 314th Engrs.

Byrne, Thomas Sneed. Capt., Ordnance, U. S. A.

Caffall, Geoffrey A. Private, No. 1 Coy., Canadian Machine Gun Depot, Seaford, Sussex, England.

Caldwell, William H. Lieut., U. S. N. R. F.

Cameron, Harry Frank. Lt.-Col., U. S. A., 209th Engrs.

Camp, George Dashiell. 1st Lieut., Engineers, U. S. A., 316th Engrs.

Campbell, Charles C. Private, Co. No. 13, Motor Group, Medical Corps, U. S. A.

Canfield, George Hathaway. Capt., Engineers, U. S. A., 316th Engrs.

Carey, Matthew L. Capt., Quartermaster Corps, U. S. A., A. E. F., France.

Carey, William N. Maj., U. S. A., 1st Bn., 313th Engrs.

Carlin, J. P. Capt., Engineers, U. S. A.

Carlson, Carl Alexius. Lt.-Commander, Civil Engineer Corps, U. S. N.

Caro, Phillip. Lieut., 2d Junior Co., No. 4 Command Depot, A. T. F., Codford, Wiltshire, England.

Carr, Dean O. Capt., U. S. A., 150th Engrs.

Carr, G. W., Jr. Co. F, 3d Provisional Regt., 156th Depot Brigade, U. S. A.

Carroll, James E. Maj., Engineers, U. S. A., 527th Engrs., A. P. O. 701, A. E. F., France.

Carter, E. Kemper. Capt., Engineers, U. S. A., Co. C, 518th Engrs.

Case, Charles A. 1st Lieut., Engineers, U. S. A., 314th Engrs.

Cate, Charles Edward. Capt., U. S. A., 45th Engrs., A. E. F., France.

Caton, John H., 3d. Capt., Engineers, U. S. A., Co. F, 33d Engrs.

Cattell, William A. Maj., Engineers, U. S. A.

Cerny, John W. Maj., Quartermaster Corps, U. S. A.

Chadwick, Maurice F. Private, 24th Tr. Bn., F. A. R. D., Camp Jackson, S. C.

Chamberlaine, Robert L. Capt., Air Service (A. P.), U. S. A.

Chambers, Frank T. Capt., Civil Engineer Corps, U. S. N.

Chandler, John Henry. 1st Lieut., Engineers, U. S. A.

Chandler, William E. Master Gunner, Headquarters Co., 55th Artillery, C. A. C., A. P. O. 723, A. E. F., France.

Chapman, Mellville D. Capt., U. S. Marine Corps, Machine Gun Bn., 5th Brigade, A. E. F., France.

Chapman, S. A. 1st Lieut., U. S. A., Headquarters, 2d Bn., 10th Engrs. (Forestry), A. E. F., France.

Chappell, Claude E. Capt., Co. 5, E. O. T. C., Camp Humphreys, Va.

Charnley, Walter. 1st Lieut., Engineers, U. S. A.

Chase, Clifford E. Capt., Engineers, U. S. A., Co. A, 4th Engrs.

Chase, Dean. 1st Lieut., Coast Artillery, U. S. A., Battery E, 62d Regt., C. A. C., A. E. F., France.

Cheney, Sherwood A. Col., U. S. A., 110th Engrs., A. E. F., France.

Cherry, Alan Gordon. 1st Lieut., U. S. A., 301st Engrs.

Chevalier, Willard T. Capt., Engineers, U. S. A., Co. D, 11th Engrs. (Ry.), A. E. F., France.

Child, John T. 1st Lieut., Sanitary Corps, U. S. A.

Childs, James A. Capt., Sanitary Corps, U. S. A.

Chipley, Dudley. Capt., Quartermaster Corps, U S. A., Constr. Div.

Chittenden, Albert Frederick. 1st Lieut., Engineers, U. S. A., Co. F, 18th Engrs. (Ry.), P. O. No. 705, A. E. F., France.

Christensen, George A. Maj., Quartermaster Corps, U. S. A.

Christie, C. de B. Capt., Engineers, U. S. A.

Christophers, Reginald Gillon. (No. 60286), 2d Lieut., 34th Reinforcements, N. Z. E. F., Care, G. P. O., Wellington, New Zealand.

Church, Elihu C. Capt., Engineers, U. S. A., A. E. F., France.

Churchill, Percival M. Maj., Engineers, U. S. A., Headquarters, 538th Engrs.

Churchill, Robert C. Lieut., U. S. A., Co. F, 12th Engrs. (Ry), A. E. F., France.

Claflin, William B. Capt., Engineers, U. S. A., Headquarters, 39th Div.

Claiborne, Herbert A., Jr. 2d Lieut., Signal Corps, U. S. A. (*Unassigned*).

Clark, Ernest A. Capt., Engineers, U. S. A.

Clark, Howard F. Capt., Engineers, U. S. A., A. E. F., France.

Clarke, Harry L. 1st Lieut., Engineers, U. S. A., Co. E, 28th Engrs.

***Clarke, Thomas C.** Lt.-Col., 110th Engrs., A. E. F., France.

Clarke, W. D. Capt., Engineers, U. S. A., 23d Engrs. (Highway), A. E. F., France.

Clarkson, Charles D. S. Capt., U. S. A., 472d Engrs.

Class, C. Frank. Capt., Engineers, U. S. A.

Clayton, Thomas W. Capt., Engineers, U. S. A., A. E. F., France.

Cleckner, Frederick M. Private, Meteorological Section, Signal Corps, U. S. A.

Cleveland, Lou B. 1st Lieut., Engineers, U. S. A., Co. D, 105th Engrs.

Clinton, Delmar S. Maj., Engineers, U. S. A.

Cobb, William R. Lieut., U. S. N. N. V., U. S. S. *Frederick.*

Cochrane, Victor Hugo. Maj., Quartermaster Corps, U. S. A.

Coe, C. S. Maj., Engineers, U. S. A., 17th Engrs. (Ry.), A. P. O. 701, A. E. F., France.

Coe, David. Capt., R. E., Care, R. C. E., Communications, A. P. O., S 1, B. E. F., France.

Coe, E. K. Maj., Engineers, U. S. A., Care, C. E. O., L. of C., U. S. M. P. O. No. 702, A. E. F, France.

Cole, Howard J. Capt., Engineers, U. S. A.

Coleman, Eugene H. Capt., Engineers, U. S. A., 312th Engrs.

Colgan, R. J. Capt., 11th Engrs. (Ry.), A. E. F., France.

Collier, W. N. Capt., Engineers, U. S. A.

Collins, Earl H. Capt., Coast Artillery, U. S. A.

Collins, Merton C. 1st Lieut., Engineers, U. S. A.

Columbia, Curtis F. 1st Lieut., Coast Artillery, U. S. A., Heavy Artillery Headquarters, A. E. F., France.

Comly, Harry S. Meteorologist, Signal Corps, 32d Service Co., Meteorological Section, U. S. A.

Comly, James R. 1st Lieut., Engineers, U. S. A., 55th Engrs.

Compton, Arthur M. Lt.-Col., U. S. A., 126th F. A.

Compton, R. Keith. Maj., Engineers, U. S. A.

Conard, Clarence Knight. Maj., Ordnance, U. S. A.

Conard, R. A. Civ. Engr., U. S. N. R. F., Port au Prince, Haiti.

Connelly, Walter L. Master Engr., Senior Grade, Headquarters Detachment, 310th Engrs.

Connolly, A. H. Cadet, School of Military Aeronautics, U. S. A.

Connolly, Donald H. Lt.-Col., Engineers, U. S. A.

Connor, W. D. Col., U. S. A., Gen. Staff; Asst. Chf. of Staff, A. E. F., France.

Converse, Joseph B. Lieut., U. S. A., Constr. Div.

Conway, N. B. Capt., Engineers, U. S. A., 516th Engrs.

Cook, Paul D. Maj., Engineers, U. S. A.

Cooke, Frederick H. Lt.-Commander, Civil Engineer Corps, U. S. N.

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* Awarded the Croix de Guerre.

Cooksey, R. M. Maj., Quartermaster Corps, U. S. A.

Coombs, Robert D. Maj., Ordnance, U. S. A.

Coomer, R. M. Capt., Engineers, U. S. A., Headquarters, Eng. Corps, Line of Communications, A. E. F., France.

Cooper, David R. Capt., Engineers, U. S. A., A. E. F., France.

Cooper, Hugh L. Lt.-Col., U. S. A., A. E. F., France.

Copeland, Robert Morris. Capt., Engineers, U. S. A.

Corkran, Wilbur Sherman. Maj., Engineers, U. S. A.

Cornell, J. W. Capt., Quartermaster Corps, U. S. A.

Cornish, Lorenzo D. Capt., Engineers, U. S. A., Co. C, 15th Engrs. (Ry.), A. E. F., France.

Corp, Henry W. Lieut., U. S. A.

Cosby, Spencer. Col., Engineers, U. S. A., 5th Engrs.

Cotter, Carl Henry. Lieut., Civil Engineer Corps, U. S. N.

Cottman, L. Warrington. Maj., Chemical Warfare Service, U. S. A.

Covert, John F. 1st Lieut., Engineers, U. S. A.

Cowles, William Pierce. Maj., Engineers, U. S. A., 34th Engrs., A. E. F., France.

Cox, Leonard M. Commander, Civil Engineer Corps, U. S. N.

Coy, Burgis G. Capt., Engineers, U. S. A., Co. D, 314th Engrs., A. E. F., France.

Cragin, Charles Calhoun. Maj., Engineers, U. S. A., 18th Engrs. (Ry.), P. O. Box 705, A. E. F., France.

Crandall, Carl. Flying Cadet, U. S. Air Service.

Crane, Albert Eli. 1st Lieut., Engineers, U. S. A., 6th Engrs., A. E. F., France.

Crane, Joseph S. Maj., Quartermaster Corps, U. S. A.

Crawford, Hugh W. Capt., U. S. A., Co. A, 110th Engrs.

Crawford, Ivan C. Maj., Engineers, U. S. A., Army Line School, A. E. F., France.

Crecelius, S. F. Lt.-Col., Engineers, U. S. A., 101st Engrs., A. E. F., France.

Crocker, Herbert Samuel. Lt.-Col., Quartermaster Corps, U. S. A.

Crocker, James R. Capt., Engineers, U. S. A., Co. F, 106th Engrs.

Cronemeyer, J. F. W. Co. 3, E. O. T. S., Camp Humphreys, Va.

Crooks, Clinton H. Capt., Engineers, U. S. A.

Crosby, Lothrop. 1st Lieut., U. S. A.

Crosby, W. W. Lt.-Col., Engineers, U. S. A.

Crowell, Francis S. Capt., Quartermaster Corps, U. S. A.

Crozier, William. Maj.-Gen., U. S. A.; Chief of Ordnance, U. S. A.

Cudebec, Albert B. Capt., Engineers, U. S. A., U. S. Military P. O. No. 702, A. E. F., France.

Culver, Arthur. Lieut., R. E., 156th Field Co., R. E., B. E. F., France.

Cunliff, Charles, Jr. Lieut., U. S. A., 403d Engrs.

Cunningham, John G. L. Capt., Ordnance, U. S. A.

Curfman, Lawrence E. Lt.-Col., 314th Engrs., A. E. F., France.

Curley, J. F. Maj., Ordnance, U. S. A.

Currey, J. W. 1st Lieut., Engineers, U. S. A., Co. C, 115th Engrs.

Currie, Thomas A., Jr. Private, 116th Engr. Detachment, A. P. O. 727, St. Aignan-Noyers, A. E. F., France.

Cushing, Edward B. Maj., Engineers, U. S. A.; Supt., Army Transport Service, U. S. A. P. O. No. 705, A. E. F., France.

Cutler, Leon G. Capt., Coast Artillery, U. S. A., 57th Artillery, C. A. C., A. E. F., France.

Daae, H. A. Capt., Engineers, U. S. A.

Dallis, Park A. Capt., Engineers, U. S. A.; Adjt., 24th Engrs.

Daly, A. P. V. 2d Lieut., 4th Connaught Rangers; 48 Cathcart Rd., London, S. W., England.

Daly, D. A. Capt., Engineers, U. S. A., 16th Engrs., A. E. F., France.

Daly, John W. Lieut., Infantry, U. S. A.

Danforth, George Clapp. Capt., Engineers, U. S. A., 602d Engrs., A. E. F., France.

Darling, Clinton Stowell. Capt., U. S. A., 108th Engrs., A. P. O. 750, A. E. F., France.

Darville, M. A. 2d Lieut., Engineers, U. S. A., A. E. F., France.

Davidson, George B. 2d Lieut., Engineers, U. S. A.

Davies, J. P. Capt., Ordnance, U. S. A.

Davis, Chandler. Capt., Engineers, U. S. A., 6th Engrs., A. E. F., France.

Davis, Daniel E. Capt., Quartermaster Corps, U. S. A.

Davis, Frederick A. W. Capt., U. S. A., 213th Engrs.

Davis, John C. Capt., Coast Artillery, U. S. A.

Davis, Robert M. 1st Lieut., Engineers, U. S. A., 57th Engrs. (Inland Waterways).

Davy, J. J. 1st Lieut., U. S. A., 23d Engrs.

Day, Warren E. Capt., Engineers, U. S. A.

Dean, Bertram D. Capt., Engineers, U. S. A., Dept., C. and F., Headquarters, S. O. S., U. S. M. P. O. 717, A. E. F., France.

Dean, Willis J. Capt., Quartermaster Corps, U. S. A.

de Charms, Richard, Jr. 1st Lieut., Engineers, U. S. A., Co. A, 503d Engrs. (Service Bn.), A. E. F., France.

Decker, Arthur J. Capt., Sanitary Corps, U. S. A.

Deets, Edward H. Capt., Quartermaster Corps, U. S. A.

DeGraff, Carlton R. 1st Lieut., Engineers, U. S. A.

Deiser, Norman A. 1st Lieut., Engineers, U. S. A.

De Leuw, Charles E. 1st Lieut., Engineers, U. S. A., 4th Engrs.

De Moss, Samuel. Sergeant, Meteorological Section, Signal Corps, U. S. A.

Dennis, William F. Maj., Engineers, U. S. A. (*Unassigned*).

Dent, Elliott J. Col., Engineers, U. S. A., 26th Engrs., A. P. O. 765, A. E. F., France.

Derby, George McC. Lt.-Col., Engineers, U. S. A.

Diesem, Harry C. Capt., Engineers, U. S. A., 404th Engr. Depot Detachment.

Diffenderfer, Claude O. Capt., Engineers, U. S. A., 534th Engrs., A. E. F., France.

Dillman, George L. Maj., Engineers, U. S. A.

Dobson, Gilbert C. Maj., Engineers, U. S. A.

Dodd, Joseph H. L. 2d Lieut., B. W. I. Regt.; Burlington, St. Margaret's Bay, Jamaica.

Doebler, Valentine S. Capt., Quartermaster Corps, U. S. A.

Doeleman, H. F. Maj., Quartermaster Corps, U. S. A.

Dohm, Edward Clarence. Capt., Engineers, U. S. A.

Donahey, Joseph A. Capt., Engineers, U. S. A.

Donaldson, Carl S. Co. G, Officers' Training School, Heavy Artillery, Fort Monroe, Va.

Donnelly, J. F. S. 1st Lieut., Engineers, U. S. A.

Doten, Leonard S. Maj., Quartermaster Corps, U. S. A.

Douglass, Louis R. Capt., Quartermaster Corps, U. S. A.

Dow, Hezekiah Shailer. 2d Lieut., 492d Constr. Squadron, Air Service, A. E. F., France.

Doyle, John S. Maj., Engineers, U. S. A.

Drayton, Newbold. Corporal, Battery D, 108th F. A., 53d Art. Brigade, 28th Div.

Drew, C. D. Capt., 11th Engrs. (Ry.), A. E. F., France.

Drummond, William W. Capt., Engineers, U. S. A., Co. B, 524th Engrs., A. P. O. 747, A. E. F., France.

Drury, William F. Capt., Engineers, U. S. A.

Du Bois, George B. 1st Lieut., Engineers, U. S. A., Commanding 6th Engr. Train, 3d Div., A. E. F., France.

Dunlap, Walter H. Capt., Engineers, U. S. A.

Dunn, Beverly C. Maj., Engineers, U. S. A.

Dunshee, Bertram K. 1st Lieut., Engineers, U. S. A., 316th Engrs.

Du Pré, Wallace Duncan. Lieut., Quartermaster Corps, U. S. A., Mech. Repair Shop Unit No. 303.

Durham, Henry Welles. Maj., Engineers, U. S. A., 41st Engrs., A. E. F., France.

Durham, Leicester. Capt., Engineers, U. S. A., A. P. O. 733, A. E. F., France.

Dykeman, Conrad F. 1st Lieut., Engineers, U. S. A., 116th Engrs., P. O. 733, A. E. F., France.

Eager, V. M. Capt., Quartermaster Corps, U. S. A.

Eason, F. G. Capt., Engineers, U. S. A., Co. A, 317th Engrs., A. P. O. 766, Mobile, A. E. F., France.

Easton, Russell B. Capt., Engineers, U. S. A.

Eckel, Edwin C. Capt., Engineers, U. S. A., Headquarters, A. E. F., France.

Eddy, Albert C. Capt., U. S. A., 55th Engrs., A. E. F., France.

Eddy, Harold M. Lieut., Civil Engineer Corps, U. S. N. R. F.

Edgerton, G. E. Col., Engineers, U. S. A.

Edmondson, Ralph S. 1st Lieut., U. S. A., 27th Engrs. (Min.).

Edmonston, A. D. 2d Lieut., Engineers, U. S. A.

Edwards, G. G. Capt., Engineers, U. S. A., Co. F, 315th Engrs.

Elliott, J. W. Capt., Engineers, U. S. A., Co. A, 602d Engrs.

Elliott, Malcolm. Lt.-Col., Engineers, U. S. A., 309th Engrs., A. O. P. 701, A. E. F., France.

Elliott, Percival. Private, Co. D, 33d Engrs.

Ellis, Gwynne W. Capt., Engineers, U. S. A., Co. E, 210th Engrs.

Ellison, Alexander H. 1st Lieut., Engineers, U. S. A., 3d Bn., 20th Engrs. (Forestry).

Eltinge, O. L. 1st Lieut., Engineers, U. S. A.

Ely, Carl B. Maj., Air Service, U. S. A.

Embury, Aymar, 2d. Capt., Engineers, U. S. A., Camouflage Section, A. E. F., France.

Emerson, George D. Capt., Quartermaster Corps, U. S. A., Constr. Div.

Emerson, Raffe. Ensign, Flying Corps, U. S. N. R. F.

Emory, Lloyd T. Capt., Ordnance, U. S. A.

Endicott, Mordecai T. Rear-Admiral, Civil Engineer Corps, U. S. N.

Enger, Arthur L. Capt., Engineers, U. S. A.

Ernst, Oswald H. Maj.-Gen., U. S. A. (*Retired*).

Estes, F. E. Capt., 17th Engrs. (Ry.), A. E. F., France.

Everett, Chester McK. Capt., Sanitary Corps, U. S. A.

Everett, Ralph B. Private, Co. F, 23d Engrs., A. E. F., France.

Everham, Arthur C. Maj., Quartermaster Corps, U. S. A.

Fahy, Joseph Augustine. Capt., Engineers, U. S. A., Co. D, 518th Engrs., A. P. O. 752, A. E. F., France.

Fairchild, John F. Maj., Quartermaster Corps, U. S. A., Brigade Headquarters, 1st Corps Troops.

Fairlie, John Walter. 1st Canadian Exp. Force (*Retired*).

Fairman, James Robert. Capt., Engineers, U. S. A.

Falk, Myron S. Maj., Ordnance, U. S. A.

Farley, M. M. 1st Lieut., Engineers, U. S. A.

Farrin, James M. Capt., Engineers, U. S. A., Co. C, 302d Engrs., A. E. F., France.

Fassett, Earle W. 1st Lieut., Engineers, U. S. A., 316th Engr. Train.

Feigel, John H. 1st Lieut., Engineers, U. S. A., A. E. F., France.

Feiner, Mark A. Meteorological Section, Signal Corps, Aviation Section, U. S. A.

Feltham, Percy M. Capt., Engineers, U. S. A.

Ferguson, Harry Foster. 1st Lieut., Engineers, U. S. A., O. C. E. O., Adv. Sec., L. of C., A. P. O. 714, A. E. F., France.

Fernald, Gordon H. Capt., Engineers, U. S. A., Co. D, 304th Engrs.

Fickes, Clark R. Maj., Engineers, U. S. A., A. E. F., France.

Fiebeger, G. J. Col., U. S. A., Headquarters, A. E. F.

Fifer, Frank P. Capt., Engineers, U. S. A., Lines of Communications, A. E. F., France.

Finley, C. MacF. Capt., Engineers, U. S. A., 503d Service Bn., A. E. F., France.

Finnell, Woolsey. Maj., Engineers, U. S. A., 501st Engrs., U. S. A. P. O. 741, A. E. F., France

Fisher, George Joseph. Lieut., U. S. A., Co. E, 219th Engrs.

Fisher, Janon. Maj., Engineers, U. S. A., 522d Engrs.

Fisk, Clinton H. Maj., Quartermaster Corps, U. S. A.

FitzGerald, C. C. Maj., Engineers, U. S. A., 32d Engrs.

Fitzgerald, Gerald C. 1st Lieut., Engineers, U. S. A., 319th Engrs.

Fitzpatrick, F. J. Capt., Engineers, U. S. A., Co. C, Service Bn., 508th Engrs., A. E. F., France.

Flagg, Herbert J. Capt., Coast Artillery, U. S. A.

Flagler, C. A. F. Brig.-Gen., U. S. A., 5th F. A. Brigade, A. E. F., France.

Fleming, Burton P. Capt., Engineers, U. S. A.

Flick, John K. Capt., Engineers, U. S. A.

Flook, Lyman R. 1st Lieut., Ordnance, U. S. A.

Fogerty, Merton S. Private, Meteorological Section, Signal Corps, U. S. A., P. O. 731^a, A. E. F., France.

Fogg, Alden K. Lieut. (Junior Grade), Civil Engineer Corps, U. S. N.

Follin, James W. 1st Lieut., Sanitary Corps, U. S. A.

Fölling, B. N. Capt., Engineers, U. S. A., Co. A, 49th Engrs., A. E. F., France.

Foote, Olney N. Lieut., U. S. A., Co. G, 322d Inf.

Forbes, Francis B. 1st Lieut., Engineers, U. S. A.

Ford, William Ellis. Capt., Engineers, U. S. A.

Forster, Arthur Oscar. Capt., Quartermaster Corps, U. S. A.

Forter, Cecil A. 1st Lieut., Sanitary Corps, U. S. A.

Forter, Samuel A. Lieut., U. S. N. R. F.; Public Works Officer, U. S. Naval Air Station, Gironde, France.

Fortney, C. Page. Capt., Engineers, U. S. A.

Foster, Ernest H. Ensign, U. S. N. R. F.

Foster, Samuel D. 1st Lieut., U. S. A., and A. D. C., Headquarters, 53d Artillery Brigade.

Fouilhoux, J. Andre. Capt., Field Artillery, U. S. A.

Fountain, Thomas L. Capt., Engineers, U. S. A., Care, C. O., 17th Engrs. (Ry.), U. S. A. P. O. 701, A. E. F., France.

Fowler, Charles Worthington. 1st Lieut., Signal Corps, Aviation Section, U. S. A., Commanding 485th Aero Constr. Squadron, A. E. F., France.

Fowler, Frank G. Capt., Quartermaster Corps, U. S. A., Constr. Div.

Fox, Henry. Capt., Engineers, U. S. A., 314th Engrs.

Fox, Stephenson W. Maj., Engineers, U. S. A.

Frank, George Stedman. Lieut., Signal Corps, Aviation Section, U. S. A., A. E. F., France.

Franklin, William H. 1st Lieut., Quartermaster Corps, Constr. Div., U. S. A.

Franks, John B. 1st Lieut., U. S. A., 7th F. A.

Freeman, William B. Capt., Engineers, U. S. A., Co. A, 509th Engrs. (Service Bn.)

French, F. C. Capt., Engineers, U. S. A., 525th Engrs.

Frickstad, Walter N. Capt., Engineers, U. S. A.

Friedman, Harry B. Lieut., Signal Corps, Aviation Section, U. S. A.

Fries, Amos A. Col., U. S. A., 30th Engrs.; Chf. of Gas Service, A. E. F., France.

Froiseth, Richard E. 1st Lieut., Engineers, U. S. A.

Frost, Edward M. Asst. Civ. Engr., U. S. N. R. F.

Fry, Alfred Brooks. Capt., U. S. N. N. V.

Furlow, Felder. Capt., Engineers, U. S. A.

Fyfe, James Lincoln. Maj., Quartermaster Corps, U. S. A.

Gabelman, Charles G. Lieut., Engineers, U. S. A.

Gailor, Chester F. Maj., Quartermaster Corps, U. S. A.

Galbreath, Albert W. 1st Lieut., Engineers, U. S. A., Co. B, 12th Engrs. (Ry.), A. E. F., France.

Gallagher, Leonard Bruce. Capt., Engineers, U. S. A., Co. D, 116th Engrs., A. E. F., France.

Galloway, John D. Maj., Engineers, U. S. A., A. E. F., France.

Galvin, James Augustine. 1st Lieut., Engineers, U. S. A.; Engr. Officer, Army General Staff Coll., U. S. A. P. O. No. 714, A. E. F., France.

Garlinghouse, R. L. Chf. Machinist's Mate, U. S. N. R. F. (*Unassigned*).

Garnett, Benjamin J. 1st Lieut., Engineers, U. S. A. (*Unassigned*), A. E. F., France.

Garrett, Robert P. Capt., Ordnance, U. S. A.

Gartensteig, Charles. Capt., Engineers, U. S. A., 535th Engrs.

Gatens, Ray S. 1st Lieut., Engineers, U. S. A., Co. C, 42d Engrs., A. E. F., France.

Gaumer, A. W. 1st Lieut., Engineers, U. S. A.

Gausmann, Roy W. Maj., Engineers, U. S. A., 1st Bn., 303d Engrs., A. E. F., France.

Gayler, E. R. Commander, Civil Engineer Corps, U. S. N., Port au Prince, Haiti.

Geib, George Albert. Capt., Engineers, U. S. A., Co. A, 527th Engrs., Service Bn.

Genung, J. H., Jr. Lieut., Engineers, U. S. A.

George, Howard H. Capt., Engineers, U. S. A., Co. E, 305th Engrs.

Getty, Lorenzo T. 1st Lieut., Signal Corps, Aviation Section, U. S. A., 75th Aero Constr. Squadron, A. E. F., France.

Gibbs, E. A. Maj., 15th U. S. Engrs. (Ry.), A. E. F., France.

Gibbs, William Wetmore. 1st Lieut., Engineers, U. S. A.

Gibson, Thomas F. Corporal, Headquarters Co., 63d Inf.

Giesen, Walter E. Private, U. S. Marine Corps, Co. 269, Bn. W.

Giesting, Frank A. Lt.-Col., Engineers, U. S. A., Headquarters, 302d Engrs., A. E. F., France.

Giffels, William C. 1st Lieut., Engineers, U. S. A.

Gilman, E. Dow. 1st Lieut., Engineers, U. S. A., 473d Engrs.

Gladding, James N. Capt., Engineers, U. S. A. (*Unassigned*), A. E. F., France.

Glander, John Henry, Jr. Ensign, Civil Engineers Corps, U. S. N. R. F.

Glazier, W. L. Maj., Engineers, U. S. A.; Commanding Officer, 525th Engrs., Service Bn., A. E. F., France.

Goddard, Leslie Drew. Capt., Engineers, U. S. A.

Godfrey, Alex. H. Asst. Paymaster, U. S. N. R. F.

Godfrey, Stuart C. Lt.-Col., Engineers, U. S. A., Headquarters, 318th Engrs., A. E. F., France.

Goethals, George R. Col., U. S. A.; Engr. Officer, Headquarters, Army Artillery, 1st Army, A. E. F., France.

Goethals, George W. Maj.-Gen., U. S. A.

Golden, William A. Ensign, U. S. N. R. F., U. S. S. *Mary Alice.*

Goldsmith, Clarence. Maj., Quartermaster Corps, U. S. A.

Gooch, Carl Joseph. Co. E, 32d Engrs.

Goodman, Benjamin. 2d Lieut., Engineers, U. S. A., 504th Engrs., Headquarters, A. E. F., France.

Goodman, Leon. Capt., U. S. A., and Adjt., 109th Engrs.

Gordon, John Blake. Care, Chf. Engr. Officer, General Headquarters, A. E. F., France.

Gordon, Samuel. Lt-Commander, Civil Engineer Corps, U. S. N.

Goss, O. P. M. Capt., Signal Corps, Aviation Section, U. S. A.

Gotwals, John C. Lt.-Col., Engineers, U. S. A., Care, O. C. E., G. H. Q., A. P. O. 706, A E. F., France.

Gough, William J. Capt., Engineers, U. S. A.

Gould, William T. Capt., Engineers, U. S. A., U. S. M. P. O. 705, A. E. F., France.

Gow, C. R. Maj., Quartermaster Corps, U. S. A.

Grady, Frank L. Sergeant, Co. I, 52d Pioneer Inf.

Graff, George W. Candidate, Field Artillery Central Officers' Training School, 29th Training Battery, Camp Zachary Taylor, Ky.

***Grant, John R.** Maj., M. C., R. E., Offizier-Gefangenenlager, Stralsund (Danholm), Germany.

Grant, Kenneth C. Maj., Quartermaster Corps, U. S. A.

Grant, U. S., 3d. Col., U. S. A.

Gravell, William Henry. Capt., Engineers, U. S. A., A. E. F., France.

Graves, E. M. Maj., Engineers, U. S. A., 529th Engrs.

Gray, Earle P. 1st Lieut., Engineers, U. S. A., 16th Engrs. (Ry.), A. E. F., France.

Gray, William B. Maj., Engineers, U. S. A.

Green, Charles N. Maj., Engineers, U. S. A.

Green, Clarence Jasper. 1st Lieut., Oregon Coast Artillery.

Green, F. W. Lt.-Col., Transportation Corps, U. S. A.; Gen. Supt., Army Transport Service, A. E. F., France.

Greene, F. S. Capt., U. S. A., Co. B, 302d Engrs.

Greenfield, Robert A. Maj., Engineers, U. S. A.

Gregory, John H. Capt., Sanitary Corps, U. S. A.

Gregory, Luther E. Capt., Civil Engineer Corps, U. S. N.

Gregory, Whitney I. Capt., Engineers, U. S. A. (*Unassigned*).

Gregory, William B. Maj., Engineers, U. S. A., A. E. F., France.

Grehan, Bernard H. 1st Lieut., U. S. A., 312th Engrs.

Griest, Maurice. 1st Lieut., Engineers, U. S. A.

Griffin, John Alden. Capt., U. S. A., Co. A, 316th Engrs.

Grigsby, Walter B. 1st Lieut., Engineers, U. S. A., 9th Engrs. (Mounted).

Grimes, James E. Capt., Quartermaster Corps, U. S. A.

Grindrod, Irvin S. 1st Lieut., Engineers, U. S. A. (*Unassigned*).

Griswold, Harry T. 2d Lieut., Coast Artillery, U. S. A.

Griswold, Hector C. Lieut. (Junior Grade), Civil Engineer Corps, U. S. N.

Griswold, Lee S. Capt., Engineers, U. S. A. (*Unassigned*).

Grodske, Walter J. Capt., Engineers, U. S. A.

Gross, Frederick H. 2d Lieut., Engineers, U. S. A., Co. B, 303d Engrs.

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* Awarded the Military Cross (British).

Gross, Henry McC. 1st Lieut., 149th Div., Machine Gun Bn., A. E. F., France.

Grunauer, Mortimer. Sergeant, Headquarters Co., 304th F. A., A. E. F., France.

Guillemette, Joseph D. 2d Lieut., Air Service, U. S. A., Air Service Depot No. 1, A. P. O. 702, A. E. F., France.

Gunther, Herman Dietrich. Co. B, 147th Inf.

Guppy, Benjamin Wilder. Maj., Engineers, U. S. A., 14th Engrs. (Ry.), A. E. F., France.

Guptill, Joseph R. Private, Co. E, 2d Bn., 23d Engrs., A. E. F., France.

Gutman, David. Maj., Engineers, U. S. A.

Haas, Philip L. Capt., Engineers, U. S. A.

Hadley, Allen S. 1st Lieut., Engineers, U. S. A.

Hains, Peter C. Maj.-Gen., U. S. A.

Halcombe, N. M. Capt., Royal Flying Corps, Egypt.

Haldeman, Walter S. Capt., Engineers, U. S. A.

Hale, Richard King. Lt.-Col., 101st F. A., A. E. F., France.

Hall, Benjamin M., Jr. 1st Lieut., Engineers, U. S. A., Co. B, 26th Engrs., A. P. O. No. 701, A. E. F., France.

Hall, Charles L. Lt.-Col., Engineers, U. S. A., Headquarters, A. E. F., France.

Hall, Gilbert G. 1st Lieut., Engineers, U. S. A., 20th Engrs.

Hall, Julius R. 1st Lieut., Engineers, U. S. A., 515th Service Bn.

Hall, Louis W. Capt., Engineers, U. S. A., Care, Director of Const. and Forestry, S. O. S., P. O. 717, A. E. F., France.

Hall, Oliver Antrum. Capt., Engineers, U. S. A., 23d Engrs., U. S. A. P. O. 738, A. E. F., France.

Hall, Warren E. Capt., Engineers, U. S. A., Co. D, 506th Engrs. (Service Bn.), Base No. 2, A. E. F., France.

Hallberg, Arthur S. 1st Lieut., U. S. N. R. F., U. S. S. *Quinnebaug.*

Hallihan, John P. Maj., Engineers, U. S. A.

Halsema, E. J. Capt., Engineers, U. S. A.

Hamilton, Edward P. 2d Lieut., Field Artillery, U. S. A., 306th F. A.

Hammill, Harold B. Lieut.; Asst. Civ. Engr., U. S. N. R. F., U. S. Naval High Power Radio Detachment, U. S. N. P. O., Bordeaux, France.

Hammond, John M. Capt., Quartermaster Corps, U. S. A.

Hanavan, William L. 1st Lieut., 9th Inf.; Adjt., 2d Bn., A. E. F., France.

Hancock, Henry Sydney, Jr. Lieut., Royal Engrs.; Field Engr., First Corps, B. E. F., France.

Hanique, Jules E. Maj., Engineers, U. S. A., 537th Engrs., A. E. F., France.

Hannan, David E. Capt., Engineers, U. S. A., A. E. F., France.

Hansen, Paul. Capt., Engineers, U. S. A. Headquarters, Advance Section, S. O. S., Office of Chf. Engr., A. E. F., France.

Hapgood, Frederic H. Co. A, 26th Engrs., A. E. F., France.

Hardaway, Benjamin H., Jr. Maj., U. S. A.

Harding, Chester. Lt.-Col., Engineers, U. S. A., Balboa Heights, Canal Zone, Panama.

Harding, Ralph L. Capt., Engineers, U. S. A., 35th Engrs.

Harley, Alfred F. Field Clerk, Engineers, U. S. A., A. E. F., France.

Harmon, W. G. Capt., Sanitary Corps, U. S. A.

Harrah, O. W. Capt., Engineers, U. S. A., 319th Engrs.

Harrington, Arthur W. 1st Lieut., Sanitary Corps, U. S. A.

Harris, F. R. Rear-Admiral, U. S. N.

Harris, Frank S. M. Lieut., U. S. N. R. F.

Harrison, William Burr. Maj., Engineers, U. S. A.

Hart, S. A. 1st Lieut., Engineers, U. S. A., 23d Engrs.

Harter, A. F. Capt., Engineers, U. S. A., Co. B, 527th Engrs., A. P. O. 769, A. E. F., France.

Harts, William W. Brig.-Gen., U. S. A., G. H. Q., 1er Echelon, B. E. F., France.

Hasbrouck, Oscar. Capt., U. S. A., Co. B, 522d Engrs., P. O. 747, A. E. F., France.

Haskins, C. A. Capt., Sanitary Corps, U. S. A.

Haskins, John C. 1st Lieut., Engineers, U. S. A., 22d Engrs.

Hastings, R. P. 1st Lieut., Engineers, U. S. A., Co. D, 26th Engrs.

Hatch, Frederick N. Capt., Engineers, U. S. A., 35th Engrs., A. E. F., France.

Hauser, Kenneth D. Capt., 18th Engrs. (Ry.), A. E. F., France.

Hawley, John B. Maj., Engineers, U. S. A., 503d Engrs., Service Bn., A. E. F., France.

Haydock, Charles. Co. 3, E. O. T. S., Camp Humphreys, Va.

Hayes, F. Eugene, Jr. Chf. Carpenter's Mate, U. S. N.

Hays, Donald S. Capt., Engineers, U. S. A.

Hays, John Coffee. Maj., Quartermaster Corps, U. S. A.

Hazelton, W. S. Capt., Ordnance, U. S. A.

Hazlehurst, James Nisbet. Maj., Engineers, U. S. A., Headquarters, S. O. S., A. E. F., France.

Healey, Charles F. Capt., Engineers, U. S. A., A. P. O. No. 701, A. E. F., France.

Hebard, R. W. Maj., U. S. A., 5th Bn., 22d Engrs., A. E. F., France.

Heck, Nicholas H. Lieut., U. S. N. R. F.

Heed, Samuel D. Capt., Ordnance, U. S. A.

Hendricks, Ernest D. Capt., Engineers, U. S. A., Co. B, 303d Engrs.

Hendrie, John Gibson. Capt., Engineers, U. S. A.; Adjt., 2d Bn., 318th Engrs. (Sappers).

Henning, Charles S., Jr. Master Engr., Co. A, 21st Engrs., A. E. F., France.

Henry, Earle Underwood. 1st Lieut., Engineers, U. S. A., 116th Engrs., Care, D. G. T., A. P. O. No. 717, A. E. F., France.

Herkness, Lindsay C. Lt.-Col., Engineers, U. S. A., 302d Engrs.

Herzig, Solon. 1st Lieut., Engineers, U. S. A., Co. F, 25th Engrs., A. E. F., France.

Heslop, D. G. Capt., Royal Engrs., O. C. Surveys, Light Rys., E. E. F., Palestine.

Heuer, W. H. Col., U. S. A. (*Retired*).

Hewett, M. W. 1st Lieut., Engineers, U. S. A., 508th Service Bn.

Hews, Wellington P. Capt., Engineers, U. S. A., 62d Engrs., A. E. F., France.

Hickok, Clifton E. Capt., Engineers, U. S. A.

Higgins, Charles H. Maj., Ordnance, U. S. A.

Hilder, Frazer C. Capt., Engineers, U. S. A., Goring Hotel, Grosvenor Gardens, London, W. 1, England.

Hiles, Elmer K. Maj., 15th U. S. Engrs. (Ry.), A. E. F., France.

Hilton, Harry L. Lieut., Civil Engineer Corps, U. S. N. R. F.

Hinrichs, Adolf. 1st Lieut., Co. 5, E. O. T. S., Camp Humphreys, Va.

Hirzel, Alfred Sparks. Capt., 1st Delaware Inf.

Hjorth, Lawrence R. Raritan Ord. Depot, Metuchen, N. J.

Hoad, William C. Lt.-Col., Sanitary Corps, U. S. A.

Hoar, Allen. Civ. Engr., U. S. N. R. F.

Hobbs, Henry W. Maj., Engineers, U. S. A.

Hodge, Henry W. Col., U. S. A.; Asst. Chf. Engr., Am. Exp. Forces, G. H. Q., A. E. F., France.

Hodges, H. F. Maj.-Gen., U. S. A.

Hoffman, Eugene R. Private, Headquarters Detachment, 26th Engrs., A. E. F., France.

Hogan, John P. Capt., 11th Engrs. (Ry.), A. E. F., France.

Holborn, Lewis A. Lieut., U. S. A., 22d Engrs.

Hollman, John G. Capt., Engineers, U. S. A., Base Section No. 4, A. E. F., France.

Hollyday, R. C. Capt., Civil Engineers Corps, U. S. N.

Holmboe, L. S. 2d Lieut., Motor Transport Corps, U. S. A.

Holmes, Thomas H. Capt., U. S. A., 311th Engrs., A. E. F., France.

Holstlaw, Charles Henry. 1st Lieut., Infantry, U. S. A., 124th Inf.

Holt, Andrew H. Capt., Engineers, U. S. A.

Hoopes, Edgar M., Jr. Capt., Quartermaster Corps, U. S. A.

Hoover, A. Pearson. Maj., Constr. Div., Quartermaster Corps, U. S. A.

Hopkinson, George Martin. Capt., Quartermaster Corps, U. S. A.

Hopper, Jean G. L. Secy. to Capt. Escale, 3d Reg. de Marche, I^{en} Etranger (Foreign Legion), 43 Avenue de l'Opera, Paris, France.

Horton, C. K. Capt., Engineers, U. S. A.; Adjt., 2d Bn., 111th Engrs., A. E. F., France.

Horton, Dwight Fred. Capt., Engineers, U. S. A.

Hough, David L. Maj., Quartermaster Corps, U. S. A.

Howard, Conway Robinson. Capt., U. S. A., 17th Engrs. (Ry.), A. E. F., France.

Howard, Gerald B. 1st Lieut., Engineers, U. S. A., Co. E, 17th Engrs. (Ry.), A. E. F., France.

Howard, Robert C. Capt., Engineers, U. S. A.; Bn. Adjt., 138th Engrs.

Howe, H. F. Capt., Engineers, U. S. A.

Howe, Wilson Tyler. Capt., Quartermaster Corps, U. S. A.

Howell, Clarence S. Capt., Engineers, U. S. A.

Howell, George P. Col., Engineers, U. S. A.

Howell, Robert P. Capt., Quartermaster Corps, U. S. A.

Hoxie, Richard L. Brig.-Gen., U. S. A. (*Retired*).

Huber, Joseph E. Lieut., U. S. A.

Huber, William T. Capt., Engineers, U. S. A.

Hudson, H. W. Maj., Staff of Director-Gen. of Transportation, Care, Director-Gen. of Transportation, A. E. F., France.

Hughes, George L. 2d Lieut., Engineers, U. S. A.

Huie, Irving V. A. Capt., U. S. A., Co. B, 1st Engrs., A. E. F., France.

Hulburd, L. S. Capt., Engineers, U. S. A.

Hull, George B. Maj., Canadian Forestry Corps, Care, C. H. Orme, Prince Rupert, B. C., Canada.

Hull, Gordon B. Gifford. Capt., Royal Engrs.; The Grange, Horton, Northampton, England.

***Hulsart, C. Raymond.** Capt., Co. B, 11th Engrs. (Ry.) A. E. F., France.

Humann, Edwin August. Private, Co. D, 4th Engrs.

Humphrey, Gilbert Edwin. Maj., Engineers, U. S. A.

Humphreys, Charles Raymond. Capt., U. S. A., 105th Engrs.

Humphreys, Ewing S. 1st Lieut., Engineers, U. S. A.

Hunt, Charles A. Civ. Engr., U. S. N. R. F.

Hunt, Conway B. Maj., Engineers, U. S. A. (*Unassigned*).

Hunt, Leigh A. Maj., 110th Engrs., A. E. F., France.

Hurlbut, H. B. Capt., Ordnance, U. S. A.

Hurley, John Patrick. Capt., Co. K, 165th Inf., A. E. F., France.

Husson, William M. Capt., U. S. A., 82d F. A.

Husted, Alva Guy. Capt., Sanitary Corps, U. S. A.

Huston, Tillinghast L'Hommedieu. Maj., Engineers, U. S. A., 1st Bn., 16th Engrs. (Ry.), A. E. F., France.

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* Awarded the Distinguished Service Cross.

Hyde, Charles G. Capt., Sanitary Corps, U. S. A., Bn. 7, Co. 28.

Hyde, Richard Lewis. 2d Lieut., Engineers, U. S. A., 10th Engrs., A. E. F., France.

Hynds, Harold D. 1st Lieut., Signal Corps, Aviation Section, U. S. A.

Ingalls, O. L. Maj., Engineers, U. S. A.

Irish, Leland W. Master Engr., 42d Bn., 20th Engrs.

Jackson, Dugald C. Maj., Engineers, U. S. A., A. E. F., France.

Jackson, Jesse A. Maj., 116th Bn., 41st Div., Signal Corps, U. S. A.

Jackson, W. B. Maj., Quartermaster Corps, U. S. A.

Jacobosky, Gilbert G. Capt., Engineers, U. S. A., Headquarters, 1st Bn., 55th Engrs., A. P. O. 738, A. E. F., France.

Jacobs, Joseph. Maj., Engineers, U. S. A., 509th Engrs. (Service Bn.), A. E. F., France.

*__Jacobson, Alfred Leon.__ Capt., Commandant, 26^{me} Batterie, 246^{me} Reg. d'Artillerie de Campagne, Secteur Postal 30, Armée Française en Campagne, France.

Jacques, Henry L. Capt., Engineers, U. S. A.

Jaenicke, William H. 2d Lieut., Engineers, U. S. A.

James, Alfred R. 1st Lieut., Quartermaster Corps, U. S. A.

James, Frank T. Capt., Engineers, U. S. A.

James, Robert Lane. 2d Lieut., 17th Engrs. (Ry.), A. E. F., France.

Jaques, J. D. Lieut., Civil Engineers Corps, U. S. N. R. F.

Jasper, T. McLean. Capt., Imperial Forces; Director of Signalling, No. 2, R. G. A., Cadet School, Maresfield Park, Sussex, England.

Jenkins, Charles M. Capt., Engineers, U. S. A.

Jenkins, Jenks B. Maj., Engineers, U. S. A.

Jennings, Charles A. Capt., Quartermaster Corps, U. S. A., Constr. Div.

Jennings, Percy J. Capt.; Adjt., 5th Pioneers Canadians (late 4th Pioneers), Care, Canadian Bank of Commerce, 2 Lombard St., London, E. C., England.

Jerrard, Leigh P. 2d Lieut., Engineers, U. S. A., Headquarters, 67th Artillery Brigade, A. E. F., France.

Jervey, Henry. Brig.-Gen., U. S. A.

Jessup, Walter E. 1st Lieut., Engineers, U. S. A., Co. C, 39th Engrs.

Jewell, Albert Hartwell. 1st Lieut., Sanitary Corps, U. S. A., Co. F, 26th Engrs., A. E. F., France.

Jewett, Thomas E. Capt., Quartermaster Corps, U. S. A.

Johnson, Francis Whittier. Lieut., Coast Artillery, U. S. A.

Johnson, Frank Melvin S. Capt., Engineers, U. S. A., 4th Div., 4th Engrs., A. E. F., France.

Johnson, George A. Lt.-Col., Quartermaster Corps, U. S. A., Constr. Div.

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* Awarded the Croix de Guerre.

Johnson, Halbert T. Sergeant, 472d Engrs.

Johnson, Hollister. 2d Lieut., Engineers, U. S. A., Co. C, 1st Bn., 20th Engrs., A. E. F., France.

Johnson, J. M. Lt.-Col., 117th Engrs., A. E. F., France.

Johnson, Louis R. Capt., Engineers, U. S. A.

Johnston, Thomas S. Capt., Engineers, U. S. A.

Jonah, F. G. Lt.-Col., Engineers, U. S. A.; Chf. Engr., Div. of Light Rys. and Roads, U. S. A. P. O. 706, A. E. F., France.

Jones, Harry E. Private, Aviation Section, Signal Corps, U. S. A., Meteorological Section.

Jones, Harvey W. Capt., Quartermaster Corps, U. S. A.

Jones, Henry L. Maj., Engineers, U. S. A. (*Unassigned*).

Jones, John H. Capt., 1st Canadian Pioneers, B. E. F., France.

Jones, Jonathan. Capt., Engineers, U. S. A., 23d Engrs.

Jones, Lewis Allen. Capt., Engineers, U. S. A.

Jones, Paul Sidney. 2d Lieut., Engineers, U. S. A.

Jones, Percival C. Corporal, Co. G, 23d U. S. Engrs., A. P. O. 716, A. E. F., France.

Jones, Sidney G. Capt., Engineers, U. S. A., Headquarters Co., 35th Engrs., A. P. O. 735, A. E. F., France.

Jordan, Harry E. Capt., Quartermaster Corps, U. S. A.

Joseph, Jacob. Private, Meteorological Section, Signal Corps, U. S. A., A. E. F., France.

Jouine, G. P. F. Sous Lieut. au 81eme Regt. d'Artillerie, A. S. No. 499, par Convois Automobiles, Paris, France.

Judson, William V. Brig.-Gen., U. S. A.

Kane, Daniel C. 1st Lieut., Engineers, U. S. A., 466th Pontoon Train.

Kane, Irving P. Capt., Engineers, U. S. A., 45th Engrs., A. E. F., France.

Karnopp, Edwin B. Capt., Engineers, U. S. A., 2d Bn., 22d Engrs.

Kastenhuber, E. G., Jr. Capt., Sanitary Corps, U. S. A.

Kaufmann, Ernst G. Private, 499th Aero Squadron.

Keenan, John T. Maj., Engineers, U. S. A., 2d Bn., Headquarters, 28th Engrs. (Quarry), A. E. F., France.

Keith, Gerald Marcy. Lieut., Engineers, U. S. A., Co. B, 116th Engrs., A. E. F., France.

Keller, Arthur R. Capt., Engineers, U. S. A.

Keller, Charles. Col., Engineers, U. S. A.

Kelly, Earl W. Capt., Engineers, U. S. A., 4th Bn., 116th Engrs., A. P. O. 733, A. E. F., France.

Kelly, Hugh Ambrose. Lieut., Engineers, U. S. A.

Kelly, William. Col., Engineers, U. S. A., 117th Engrs., A. E. F., France.

Kemp, John E. Capt., Engineers, U. S. A.; Chf. Engr., Ordnance Depot in France, Care, J. H. Hood, 4 rue d'Auber, Paris, France.

Keys, Edward A. Capt., Engineers, U. S. A., Co. C, 511th Engrs. (Service Bn.), U. S. A. P. O. 738, A. E. F., France.

Khachadoorian, H. H. 1st Lieut., Engineers, U. S. A., Co. C, 55th Engrs.

King, Clifford M. Capt., Engineers, U. S. A., 313th Engrs.

King, Eric T. Maj., Quartermaster Corps, U. S. A.

King, Howard L. 2d Lieut., Engineers, U. S. A., Co. B, 27th Engrs.

King, Thomas R. 1st Lieut., Engineers, U. S. A., 116th Engrs., A. P. O. 733, A. E. F., France.

King, W. S. Capt., Quartermaster Corps, U. S. A.

Kingsley, E. A. Maj., Engineers, U. S. A., A. E. F., France.

Kingsley, George. Capt., Engineers, U. S. A.

Kinne, G. W. Capt., Engineers, U. S. A.

Kinnear, Lawrence W. 2d Lieut., Aviation Section, Signal Corps, U. S. A.

Kipp, Frederick M., Jr. 33d Engrs., U. S. A.

Kirby, Luther H. Capt., Engineers, U. S. A.

Kirschner, Charles. Student (Private), E. O. T. S., Camp Humphreys, Va.

Kissack, A. B. Capt., Engineers, U. S. A.

Kitchen, Ernest. 1st Lieut., Engineers, U. S. A.

Kittredge, Frank A. Capt., U. S. A., 43d Engrs., A. E. F., France.

Kittredge, Harry C. Capt., Engineers, U. S. A.

Kitts, Joseph A. Capt., Engineers, U. S. A., U. S. A. P. O. 701, A. E. F., France.

Kleinschmidt, H. S. Capt., Engineers, U. S. A.

Klinck, J. H. Maj., Quartermaster Corps, U. S. A.

Kluegel, Harry A. Maj., Quartermaster Corps, U. S. A.

Knight, G. W. Capt., Engineers, U. S. A., 46th Engrs., A. E. F., France.

Kniskern, Philip Wheeler. Capt., Engineers, U. S. A.

Knollman, Enno P. Ensign, U. S. N. R. F.

Knost, W. A. 1st Lieut., Coast Artillery, U. S. A.

Knox, Jean H. Lieut., U. S. N. R. F., Care, U. S. Naval Aviation Forces, Paris, France.

Kohl, Frank E., Jr. Sergeant, Co. C, 302d Engrs., A. E. F., France.

Koop, Louis D. Capt., Quartermaster Corps, U. S. A.

Krach, Fred R. Private, Co. A, 23d Engrs.

Kreamer, A. W. 1st Lieut., Engineers, U. S. A. (*Unassigned*).

Krigbaum, Lowell G. 1st Lieut., Engineers, U. S. A., Care, Director of C. and F., A. E. F., France.

Kromer, Clarence H. 1st Lieut., U. S. A., 403d Engrs.

Kutz, Charles W. Brig.-Gen., U. S. A.

La Bach, Paul M. Maj., Engineers, U. S. A., A. E. F., France.

Labsap, Alfred H. 1st Lieut., Engineers, U. S. A., 114th Engrs.

La Forge, Frederick W. Maj., Engineers, U. S. A.

Lake, Edward N. Maj., Quartermaster Corps, U. S. A.

Lambert, Byron J. Maj., Engineers, U. S. A., 23d Engrs. (Highway).

Lamphere, Frank E. Col., Quartermaster Corps, U. S. A.

Lamson, William M. Maj., Engineers, U. S. A., 306th Engrs.

Lancashire, Forest H. Capt., Engineers, U. S. A.

Land, John T. Capt., Engineers, U. S. A.

Lane, Albert L. Capt., U. S. A., 50th Inf.

Lane, E. W. 2d Lieut., Air Service (A.), U. S. A.

Lansdale, John. Maj., Engineers, U. S. A., Care, D. of C. and F., A. P. O. 717, A. E. F., France.

Larkin, C. Raymond. Reclamation Officers' Training Camp, Camp Joseph E. Johnston, Fla.

La Roche, Arthur L. 1st Lieut., Engineers, U. S. A., A. E. F., France.

Larrison, George K. Capt., Engineers, U. S. A., Headquarters, Hawaiian Dept., U. S. A., Honolulu, Hawaii.

Lathbury, Benjamin Brentnall. Lt.-Col., Ordnance, U. S. A.

Latimer, C. A. 2d Lieut., Engineers, U. S. A.

Laughlin, Harmon L. Capt., Engineers, U. S. A.; Topographical Officer, 108th Engrs.

Laverty, Samuel Perry. Regt. Sup. Sergeant, 316th Am. Tr.

Lawrence, Frank Elmaker. Capt., 17th Engrs. (Ry.), A. E. F., France.

Lawton, Richard M. Maj., Engineers, U. S. A., A. P. O. 721, A. E. F., France.

Lea, Sumter, Jr. 1st Lieut., Quartermaster Corps, U. S. A.

Learned, A. P. 1st Lieut., Sanitary Corps, U. S. A.

LeBaron, R. W. P. 1st Lieut., Co. C, 13th Engrs. (Ry.), A. E. F., France.

Leckie, Alexander R. Capt., U. S. A., 111th Engrs.

Lee, Alonzo Church. 1st Lieut., Infantry, U. S. A., 17th Machine Gun Bn., A. E. F., France.

Lee, Augustine L. Maj., U. S. A.; C. O., 504th Engrs.

Lee, Charles A. Lieut. (Senior Grade), U. S. N. R. F.

Lee, Charles H. 1st Lieut., Engineers, U. S. A., Care, Chf. Engr. Officer, A. E. F., A. P. O. 717, Water Supply Section, A. E. F., France.

Lee, John Louis. Maj., Quartermaster Corps, U. S. A.

Leeds, Charles T. Maj., Engineers, U. S. A.

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Lyons, Harold C. 1st Lieut., Engineers, U. S. A., Co. B, 1st Bn., 20th Engrs., A. E. F., France.

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McCrone, R. M. 1st Lieut., U. S. A.

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McDonald, Harry L. Capt., Engineers, U. S. A.

McDonald, W. N. Capt., Engineers, U. S. A.

McDonnell, Francis R. Lieut. (Junior Grade), U. S. N. R. F.

McDonough, Michael J. Col., U. S. A., 114th Engrs.

McFarland, H. F., Jr. 1st Lieut., Co. F, 12th Engrs. (Ry.), A. E. F., France.

McGee, Arthur B. Sergeant, Ordnance, U. S. A.

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McGee, Roger K. Capt., Engineers, U. S. A.

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McGrew, John A. Maj., Quartermaster Corps, U. S. A.

McIntosh, Samuel F. Capt., Ordnance, U. S. A.

McIntyre, Lewis W. 2d Lieut., Coast Artillery, U. S. A.

McKay, George A. Commander, Civil Engineer Corps, U. S. N.

McKenney, Charles A. Col., Engineers, U. S. A.

McKinstry, Charles Hedges. Brig.-Gen., U. S. A., 67th F. A. Brigade, A. E. F., France.

McLane, G. L. Capt., Engineers, U. S. A.; Adjt., 110th Engrs.

***McLoud, Paul.** 1st Lieut., Engineers, U. S. A., Co. F, 11th Engrs., A. E. F., France.

McMeekin, Charles William. Maj., Engineers, U. S. A.

McMillan, W. Bruce. 1st Lieut., Engineers, U. S. A., A. E. F., France.

McMullen, Clements. Lieut., Aviation Section, Signal Corps, U. S. A.

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McRae, H. C. 1st Lieut., Engineers, U. S. A., 45th Engrs., A. E. F., France.

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Madison, James T. 1st Lieut., Engineers, U. S. A.

Mahon, John M., Jr. Capt., Tank Corps, U. S. A., Commanding 310th Brigade Headquarters.

Mail, Eugene Frederick. 1st Lieut., Engineers, U. S. A., 4th Engrs.

Malloy, John Michael. Lieut., U. S. A., 342d F. A.

Malone, George W. Lieut., U. S. A., 145th F. A., A. E. F., France.

Malsbury, Omer Evert. Capt., Engineers, U. S. A., 3d Engrs., Corozal, Canal Zone, Panama.

Maltby, Frank B. Maj., Engineers, U. S. A., A. E. F., France.

Mandigo, Clark R. Capt., Engineers, U. S. A., 314th Engrs.

Mangold, John Frederic. Capt., Engineers, U. S. A. (*Unassigned*).

Manning, William J. H. 2d Lieut., Engineers, U. S. A., 52d Engrs., A. E. F., France.

Mansfield, Newton. Lt.-Commander, U. S. N. (*Retired*).

March, George Miles. 1st Lieut., Engineers, U. S. A., 507th Engrs.

Marks, Edwin H. Lt.-Col., Engineers, U. S. A., 20th Engrs.

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* Awarded the Distinguished Service Cross.

Marrian, Ralph R. 2d Lieut., Engineers, U. S. A., Co. B, 105th Engrs.

Marshall, Robert B. Maj., Engineers, U. S. A.

Marston, Anson. Maj., Engineers, U. S. A.

Martin, James Walter. Capt., Engineers, U. S. A.

Marx, Raymond. 2d Lieut., Co. K, 308th Inf., A. E. F., France.

Maslen, Harold C. Ensign, U. S. N. R. F.

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Mears, Frederick. Col., U. S. A., 31st Engrs., A. P. O. 718, Care, D. G. T., A. E. F., France.

Mechlin, O. A. Lt.-Commander, U. S. N. R. F.

Melin, Reynold F. Capt., Ordnance, U. S. A.

Mellon, Albert E. Capt., Heavy Artillery, U. S. A., A. E. F., France.

Melton, Arthur Pomeroy. Capt., Engineers, U. S. A., Headquarters, Lines of Communication, A. E. F., France.

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Mengel, Carl W. 1st Lieut., Engineers, U. S. A., Co. B, 306th Engrs.

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Merriam, C. A. Capt., Engineers, U. S. A.

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Miller, Daniel C. 1st Lieut., Engineers, U. S. A.

Miller, George S. Maj., Engineers, U. S. A.

Miller, Hugh. Capt., Engineers, U. S. A.

Miller, John O. 2d Lieut., Infantry, U. S. A.

Miller, K. A. Sergeant, Co. F, 603d Engrs., A. E. F., France.

Millis, John. Col., Engineers, U. S. A.

Mills, Guy G. Capt., Engineers, U. S. A.

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Montgomery, Albertis. 1st Lieut., Engineers, U. S. A.

Moore, James A. Capt., Engineers, U. S. A., Headquarters, 2d Bn., 110th Engrs., A. E. F., France.

Moore, Lewis E. Capt., Engineers, U. S. A., A. E. F., France.

More, Charles C. Maj., Ordnance, U. S. A.

Morelock, John Earl. 2d Lieut., Engineers, U. S. A., 116th Engrs., Care, Engr. Purchasing Office, U. S. P. O. 702, A. E. F., France.

Morey, Edward F. Capt., Field Artillery, U. S. A.

Morgan, Thomas C. Sergeant, Battery C, 304th F. A., A. E. F., France.

Moriarty, Clarence. 1st Lieut., Engineers, U. S. A.

Morrow, B. S. Capt., Engineers, U. S. A.

Morrow, D. C. Capt., Quartermaster Corps, U. S. A.

Morrow, Jay J. Brig.-Gen., U. S. A., A. E. F., France.

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Ober, Ralph H. Capt., Engineers, U. S. A.

O'Connell, George P. Capt., Engineers, U. S. A.

Odoni, Vincent P. Ensign, U. S. N. R. F.

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Parker, William E. Lt.-Commander, U. S. N. R. F.

Parks, C. W. Rear-Admiral, Civil Engineer Corps, U. S. N.; Chf. of Bureau of Yards and Docks, Navy Dept.

Parsons, Archibald Livingstone. Commander, Civil Engineer Corps, U. S. N.

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Parsons, Harold A. Capt., Quartermaster Corps, U. S. A.

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Patstone, Lewis F. Maj., Engineers, U. S. A.

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Payne, Louis W. Master Engr., Senior Grade, Headquarters Co., 2d Bn., 22d Engrs., A. E. F., France.

Pearce, R. B. 1st Lieut., Engineers, U. S. A.

Pease, H. T. Capt., U. S. A., 316th Trench Mortar Battery.

Peck, John S. Private, U. S. A., S. M. A., Photo. Div.

Pendleton, Thomas Percy. Lieut., Engineers, U. S. A.

Pennell, J. Roy. Capt., Engineers, U. S. A., Co. A, 117th Engrs., A. E. F., France.

Pense, E. H. Lieut., Canadian Corps, Tramway Co. No. 2, C. E., France.

Perkins, A. H. Capt., Engineers, U. S. A., 17th Engrs. (Ry.), A. E. F,. France.

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Perrin, Lester W. Capt., U. S. A., 301st Inf.

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Perry, F. W. Maj., Engineers, U. S. A.

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Philips, J. H. Maj., Quartermaster Corps, U. S. A.

Phillips, Walter B. Capt., Quartermaster Corps, U. S. A.

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Pickett, Frank Hurd. 1st Lieut., Engineers, U. S. A., 1st Replacement Engrs.

Pierce, Charles W. Ensign, Civil Engineer Corps, U. S. N., U. S. S. *Pittsburgh.*

Pierce, P. L. Lt.-Col., Ordnance, U. S. A., Care, C. P. O., U. S. Army P. O. 702, A. E. F., France.

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Pill, Leon Morley. Capt., Engineers, U. S. A.; Adjt., 1st Bn., 20th Engrs., A. E. F., France.

Pillsbury, G. B. Col., U. S. A., 115th Engrs.

Pirnie, H. Malcolm. Lieut.; Asst. Engr., Headquarters, Director-General of Transportation, A. E. F., France.

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Poole, J. H. Maj., 16th Engrs., A. E. F., France.

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Porter, H. G. Capt., Sanitary Corps, U. S. A.

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Post, A. J. 2d Lieut., Quartermaster Corps, U. S. A., Constr. Div.

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Preston, Harry L. Capt., Engineers, U. S. A., 22d Engrs.

Price, Philip W. Lieut., U. S. A., 3d F. A.

Price, W. E. Capt., Quartermaster Corps, U. S. A.

Prichett, Frederic B. Lieut., 109th F. A., Headquarters Co., 28th Div., A. E. F., France.

Prindle, Franklin C. Rear-Admiral, Civil Engineer Corps, U. S. N. (*Retired*).

Pritchard, J. C. 1st Lieut., Engineers, U. S. A., 26th Engrs.

Proctor, R. F. Lt.-Col., Quartermaster Corps, U. S. A.

Pruett, G. C. Capt., Engineers, U. S. A.

Puckett, Homer. Capt., Engineers, U. S. A.

Pugh, Marshall R. Maj., 21st Engrs. (Light Ry.), A. E. F., France.

Pulligny, J. L. de. (Commandant); Chef de Bataillon du Genie Horscardres, French Army, 40 rue Barbey de Jouy, Paris, VII, France.

Pung, William Sing-Chong. Lieut., Engineers, U. S. A.

Purcell, Steuart. Capt., Engineers, U. S. A.

Quilty, T. Frank. Maj., Engineers, U. S. A.

Quinby, Edwin R. Headquarters, A. E. F., France.

Quinlan, George A. Maj., U. S. A., 113th Engrs.

Quinn, John I. 1st Lieut., Engineers, U. S. A., 116th Engrs., A. E. F., France.

Quinn, Matthew F. Maj., Engineers, U. S. A.

Quinn, Richard. Maj., Engineers, U. S. A. (*Unassigned*), Honolulu, Hawaii.

Quinn, Thomas F. 1st Lieut., Engineers, U. S. A., 15th Engrs., U. S. A. P. O. 741, A. E. F., France.

Rader, Frank K. 1st Lieut., Engineers, U. S. A.

Rader, James W. 2d Lieut., Aviation Section, Signal Corps, U. S. A.

Rakestraw, C. L. 1st Lieut., Engineers, U. S. A., 4th Engrs.

Randolph, John Hampden, Jr. Capt., Engineers, U. S. A., 103d Engrs.

Randolph, Robert Isham. Maj., Engineers, U. S. A., 23d Engrs.

Ranney, Alfred Gardner. Capt., Coast Artillery, U. S. A., Battery A, 65th Artillery.

Rathjens, George W. Lt.-Col., U. S. A., 313th Engrs., A. P. O. 795, A. E. F., France.

Reding, James H. Capt., U. S. A., Co. A, 112th Engrs., A. P. O. 763, A. E. F., France.

Reed, Carl S. Maj., Ordnance, U. S. A.

Reed, Howard S. Capt., Engineers, U. S. A.

Reed, Paul Lyon. Commander, Civil Engineer Corps, U. S. N.

Reed, Percy Lawrence. 1st Lieut., Ordnance, U. S. A.

Reeder, Harry C. 1st Lieut., Engineers, U. S. A.

Rees, Bird Le Grand. Capt., Engineers, U. S. A.

Reeves, Carl H. Maj., Quartermaster Corps, U. S. A.

Reeves, Glenn S. Co. G, 23d Engrs., U. S. A. P. O. 784, A. E. F., France.

Reilly, Charles G. Lieut., Co. D, 313th Inf., A. E. F., France.

Renshaw, Alfred. Capt., Engineers, U. S. A., Headquarters Co., 302d Engrs., A. E. F., France.

Renshaw, F. O. 3d Engrs., Schofield Barracks, Hawaii.

Reynolds, Leo. F. 2d Lieut., Air Service (A.), U. S. A.

Reynolds, Ralph Whitney. 1st Lieut., U. S. A., 37th Engrs., A. E. F., France.

Rhoades, Theodore E. Capt., Engineers, U. S. A.

Rhodes, Eric H. Lieut., Australian Field Engrs., France.

Rice, John T. Capt., Engineers, U. S. A.

Rich, Edward D. Maj., Sanitary Corps, U. S. A.

Rich, Melvin S. 1st Lieut., Engineers, U. S. A., G. P. A., Labor Bureau, A. P. O. 702, A. E. F., France.

Richards, Walter A. 1st Lieut., U. S. A., A. E. F., France.

Richardson, F. H. Capt., Engineers, U. S. A. (*Unassigned*).

Richardson, James H. Capt., Engineers, U. S. A.

Richardson, R. D. Capt., Engineers, U. S. A.

Riché, Charles S. Col., Engineers, U. S. A., Balboa Heights, Canal Zone, Panama.

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Riddle, William C. Capt., Sanitary Corps, U. S. A.

Ridgeway, George A. 1st Lieut., Engineers, U. S. A., 23d Engrs.

Riney, Arthur Herbert. Capt., Engineers, U. S. A., Co. A, 28th Engrs., A. E. F., France.

Ripley, Blair. D. S. O.; Lt.-Col., 1st Bn., Canadian Ry. Troops, B. E. F., France.

Ripley, Theron M. Maj., Engineers, U. S. A.

Risley, W. I. Capt., Engineers, U. S. A., 504th Engr. Bn., A. E. F., France.

Ritchie, J. Milton. Maj., Motor Transport Corps, U. S. A.

Ritow, Herman. Co. B, 302d Engrs., A. E. F., France.

Ritter, Rollin. Capt., U. S. A., 130th F. A.

Roberts, Harry A. Capt., Engineers, U. S. A.

Roberts, Leo Bond. Lieut., Engineers, U. S. A., 25th Engrs.

Robertson, A. K. Lieut., Royal Anglesea R. E., No. 3 (Ry. Cos.), France.

Robertson, Fonzie E. Lieut., Field Artillery, U. S. A.

Robinson, Edward W. Capt., Engineers, U. S. A.

Robinson, Ernest F. Capt., Engineers, U. S. A., 102d Engrs., A. E. F., France.

Robinson, John Harvey. Private, Co. B, 314th Machine Gun Bn., A. E. F., France.

Robinson, William Ernest. Lieut., Engineers, U. S. A., Co. E, 1st Engrs., A. E. F., France.

Robson, Frederick T. Capt., Engineers, U. S. A., Headquarters, 82d Div., A. E. F., France.

Robson, Ralph E. Capt., Engineers, U. S. A., 316th Engrs.

Roby, Harrison G. Lieut. (Senior Grade), Civil Engineer Corps, U. S. N. R. F.

Rockenbach, S. D. Brig.-Gen., U. S. A., G. H., A. E. F., France.

Rockhold, J. E. 1st Lieut., Co. E, 117th Engrs., A. E. F., France.

Rogers, H. Lincoln. Lt.-Commander, Civil Engineer Corps, U. S. N. R. F.

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Ropes, E. H. Lt.-Col., Engineers, U. S. A.

Rose, W. H. Brig.-Gen., U. S. A.

Rosenfeld, James R. 2d Lieut., Engineers, U. S. A., Co. D, 26th Engrs.

Rosher, Edward Marshall. Maj.; Deputy Supt. (Eng.), Mesopotamian Rys., Baghdad, West, Care, Asst. Director of Rys., Baghdad, West Div., Mesopotamia.

Ross, James G. Capt., Engineers, U. S. A., Co. C, 306th Engrs.

Ross, Lloyd McC. Private, Quartermaster Corps, U. S. A., Supply Co. 336, A. E. F., France.

Ross, Thomas A. Capt., Royal Engrs.; 2 A Whitehall Courts, London, S. W., England.

Rossell, Paul Francis. Capt., Engineers, U. S. A.; Adjt., 2d Bn., 23d Engrs., A. E. F., France.

Rothrock, W. P. Maj., Engineers, U. S. A.

Rourke, J. A. Capt., Quartermaster Corps, U. S. A., Constr. Div.

Rousseau, Harry Harwood. Rear-Admiral, Civil Engineer Corps, U. S. N.

Rowe, Donald H. Lieut., Engineers, U. S. A.

Rowland, James W. Capt., Engineers, U. S. A., 214th Engrs.

Royal, Joseph N. 2d Lieut., Engineers, U. S. A., Headquarters, 53d Engrs.

Royall, Edward M. Asst. Civ. Engr., U. S. N. R. F.

Ruggles, Arthur V. Capt., Engineers, U. S. A., 17th Engrs., A. E. F., France.

Russell, Claud. Capt., Co. 7, E. O. T. S., Camp Humphreys, Va.

Russell, William Hepbourne. 1st Lieut., U. S. A., 5th F. A.

Rust, H. P. Lieut., Canadian Engineers.

Ruth, Edgar K. Capt., Engineers, U. S. A.

Ryan, Walter J. Capt., Engineers, U. S. A.

Ryland, Reis J. 2d Lieut., Signal Corps, U. S. A., 323d Field Sig. Bn.

Ryon, Henry. 1st Lieut., Quartermaster Corps, U. S. A.

Sackett, A. J. Maj., Quartermaster Corps, U. S. A.

Sacks, Samuel I. Officers' Material Corps, U. S. N. R. F.

Sadler, Carl L. Capt., Engineers, U. S. A.

Sadler, Walter Clifford. 1st Lieut., Co. F, 18th Engrs. (Ry.), U. S. Army P. O. No. 705, A. E. F., France.

St. John, R. U. 2d Lieut., Aviation Section, Signal Corps, U. S. A.; Information Officer, 95th Aero Squadron, A. E. F., France.

Salisbury, Alfred J., Jr. 1st Lieut., A. S. P., U. S. A., Aero Squadron No. 498.

Sample, William D. Corporal, 60th Trench Mortar Battery, B. E. F., France.

Sanger, Walter M. Capt., Engineers, U. S. A., A. E. F., France.

Sargent, Edward H. Capt., Engineers, U. S. A., 116th Engrs., A. E. F., France.

Sargent, J. A. Capt., Engineers, U. S. A., Care, Headquarters, Lines of Communications, A. E. F., France.

Saurbrey, Henry A. d'O. Capt., Engineers, U. S. A.

Sawyer, Charles L. 1st Lieut., Engineers, U. S. A.

Scammell, John Kimball. Lieut., 13th Reserve Bn., Canadian, Seaford, Sussex Co., England.

Schanck, F. R. Maj., Ordnance, U. S. A.

Scharff, Maurice R. Capt., Engineers, U. S. A.; Office of Chf. Engr., A. E. F., Tours, France.

Scheidenhelm, F. W. Capt., Engineers, U. S. A., Care, Chf. Engr., A. E. F., France.

Schenk, Ernest E. Student, 1st Lieut., Engineers, U. S. A., Co. 2, E. O. T. S., Camp Humphreys, Va.

Schermerhorn, Richard, Jr. Capt., Sanitary Corps, U. S. A.

Schmucker, Beale M. 1st Lieut., U. S. A., 104th Engrs.

Schoder, Ernest W. Capt., Engineers, U. S. A.

Scholtz, H. F. Capt., Engineers, U. S. A.

Schoonmaker, Leon M. Capt., Engineers, U. S. A.

Schroeder, Seaton, Jr. Lieut. (Junior Grade), Civil Engineer Corps, U. S. N. R. F.

Schwartz, Lloyd. Acting Master Gunner, Headquarters Co., 72d Artillery Regt.

Schwendener, K. DeW. Capt., U. S. A., 115th Engrs.

Scott, Lewis P. 1st Lieut., Engineers, U. S. A.

Scudder, Charles Morrison. Capt., Co. E, 107th Engrs., A. E. F., France.

Scudder, Henry D., Jr. 2d Lieut., United States Guards, U. S. A.

Seabury, George T. Maj., Quartermaster Corps, U. S. A., Constr. Div.

Seage, Clarence E. Ensign, U. S. N.

Searight, George Peter. 1st Lieut., Engineers, U. S. A., Co. B, 27th Engrs., A. E. F., France.

Seelye, Seth H. Co. G, 23d Engrs., A. E. F., France.

Selander, John E. Maj., Royal Engrs., Care A. D. Rys., B. E. F., Italy.

Senior, Frank S. Maj., Railroad Transportation Corps, U. S. A., Care, Director General of Transportation, A. P. O. 717, A. E. F., France.

Sessler, Grover C. Asst. Civ. Engr., U. S. N. R. F.

Seward, Oscar A., Jr. Capt., Engineers, U. S. A., 315th Engrs.

Sewell, John Stephen. Col., Engineers, U. S. A., Commanding Base Section No. 1, A. E. F., France.

Sexton, George F. Sergeant, 1st Class.

Seymour, Horatio. Capt., Quartermaster Corps, U. S. A., Constr. Div.

Shafer, Ernest Alton. 1st Lieut., Engineers, U. S. A.

Shafer, J. C. F. Capt., Coast Artillery, U. S. A., A. E. F., France.

Shankland, Ralph Graham. 1st Lieut., Engineers, U. S. A.

Shaw, Arthur Lassell. Capt., Engineers, U. S. A., 301st Engrs.

Shaw, Arthur M. Maj., Engineers, U. S. A., Mech. Repair Unit No. 305.

Shaw, Franklin Dickinson. Capt., Engineers, U. S. A.

Shearer, D. McD. Capt., Engineers, U. S. A., 604th Engrs.

Sheley, Horace W. Capt., Engineers, U. S. A.

Shepard, George Milson. Capt., Engineers, U. S. A., Commanding 2d Bn., Headquarters, 606th Engrs.

Sheppard, Norman K. Master Engr., Junior Grade, Headquarters Co., 313th Engrs.

Sheridan, L. V. 2d Lieut., Artillery Section, Am. Anti-Aircraft School, U. S. A. P. O. 702, A. E. F., France.

Sherman, Edward C. Lt.-Commander, Civil Engineer Corps, U. S. N. R. F.

Shibley, Kenneth. Capt., U. S. A., 403d Engrs.

Sibert, William L. Maj.-Gen., U. S. A.

Silsbee, J. A. 1st Lieut., Ordnance, U. S. A.

Silvernail, Alfred Kimberly. Capt., Quartermaster Corps, Constr. Div., U. S. A.

Sjovall, Arvid H. Capt., Quartermaster Corps, Utilities Dept., U. S. A.

Skelly, J. W. Capt.; Supply Officer, 12th Engrs. (Ry.), A. E. F., France.

Sleight, Reuben Benjamin. Lieut., Signal Corps, U. S. A.

Slifer, Hiram J. Lt.-Col., 21st Engrs. (Light Ry.), A. E. F., France.

Sloan, William Glenn. 1st Lieut., Engineers, U. S. A. (*Unassigned*).

Sloan, William Griffith. Maj., Engineers, U. S. A.

Slocum, C. L. Capt., Ordnance, U. S. A.

Small, James H., Jr. Maj., Quartermaster Corps, U. S. A.

Smallman, R. A. Capt., Co. F, 25th Engrs., A. E. F., France.

Smead, R. C. Maj., Engineers, U. S. A. (*Unassigned*).

Smillie, Ralph. Ensign, U. S. N., U. S. S. *Massachusetts.*

Smith, Albert. Maj., U. S. A., 2d Bn., 309th Engrs.

Smith, Alexander Crawford, Jr. 1st Lieut., Engineers, U. S. A., Truck Co. No. 10, 23d Engrs., A. E. F., France.

Smith, Charles E. Maj., Quartermaster Corps, U. S. A.

Smith, Chester Alexander. Capt., Sanitary Corps, U. S. A.

Smith, Chester K. Capt., Engineers, U. S. A., Care, Director of Constr. and Forestry, Headquarters, S. O. S., A. E. F., France.

Smith, Claire Howland Wallace. 1st Lieut., Engineers, U. S. A. (*Unassigned*), A. E. F., France.

Smith, Clarence Urling. Capt., Co. E, 107th Engrs., A. E. F., France.

Smith, Clarke Stull. Col., Engineers, U. S. A., Headquarters, 311th Engrs.

Smith, Edward King. 2d Lieut., Signal Corps, U. S. A.

Smith, Everett C., Jr. Capt., U. S. A., Co. A, 34th Engrs., A. P. O. 713, A. E. F., France.

Smith, Francis M. Capt., Engineers, U. S. A., Headquarters, 59th Engrs. (Ry.), U. S. A. P. O. 708, A. E. F., France.

Smith, Landon G. 1st Lieut., U. S. A., Co. I, 3d Bn., 22d Engrs., P. O. 703, A. E. F., France.

Smith, Layton Fontaine. Lieut., U. S. N. R. F.

Smith, Maxwell W. Capt., Engineers, U. S. A., Co. F, 308th Engrs., A. E. F., France.

Smith, Merritt H. Col., 1st N. Y. Field Artillery, N. G. U. S.

Smith, Richard B. Private, 32d Service Co., Meteorological Section, U. S. A., Detached Air Service, A. E. F., France.

Smith, Robert C. Maj., Quartermaster Corps, U. S. A.

Smith, Schuyler M. Capt., Engineers, U. S. A., Bridge Section, Chf. Engr.'s Office, General Headquarters, A. E. F., France.

Smith, Shaler G. Lieut. (Student), Co. 4, E. O. T. S., Camp Humphreys, Va.

Smith, W. W. Master Engr., 16th Engrs. (Ry.), A. E. F., France.

Smoot, Lloyd D. Capt., Quartermaster Corps, U. S. A.

Snell, Edward Beniah. 1st Lieut., Engineers, U. S. A.

Snodgrass, W. T. Sergeant, Co. C, 28th Engrs., A. E. F., France.

Snook, Thomas E., Jr. Capt., Engineers, U. S. A., 306th Engrs.

Snyder, Frederic Antes. Col., U. S. A., 103d Engrs.

Snyder, George Duncan. Capt., U. S. A., 102d Engrs.

Snyder, Hubert Earl. Capt., Engineers, U. S. A.

Soest, Hugo C. 1st Lieut., Engineers, U. S. A., Co. A, 25th Engrs., A. E. F., France.

Solomon, G. R. Maj., Engineers, U. S. A.

Soper, George A. Maj., Sanitary Corps, U. S. A.

Sourwine, J. A. Capt., Engineers, U. S. A.

Spear, Philip H. Capt., Engineers, U. S. A., Care, D. M. E. and E. S., P. O. 717, A. E. F., France.

Spear, Walter E. Maj., Quartermaster Corps, U. S. A.

Spencer, Charles B. Lieut., Care, Chf. Ord. Officer, P. O. 717, A. E. F., France.

Spencer, Herbert. Capt., Engineers, U. S. A., Co. H, 23d Engrs., A. E. F., France.

Sperry, L. N. 1st Lieut., Engineers, U. S. A., 6th Engrs., A. E. F., France.

Sprague, H. M. 1st Lieut., Engineers, U. S. A., Care, G. P. A., Labor Bureau, A. P. O. 702, A. E. F., France.

Stafford, Fred D. Capt., Engineers, U. S. A., 105th Engrs., A. E. F., France.

Stallings, John R. Sergeant, Headquarters Co., 3d Anti-Aircraft Bn.

Stanford, Homer R. Commander, Civil Engineer Corps, U. S. N.

Stanley, W. E. 1st Lieut., Engineers, U. S. A., Co. B, 101st Engrs., A. E. F., France.

Stanton, Charles B. Capt., Engineers, U. S. A., Co. E, 15th Engrs. (Ry.), A. E. F., France.

Stanton, W. L. 2d Lieut., Engineers, U. S. A., 304th Engrs.

Stark, Burr M. Private, Co. 5, E. O. T. S., Camp Humphreys, Va.

Starr, F. Charles. Capt., Quartermaster Corps, U. S. A.

Starrett, William A. Col., Quartermaster Corps, U. S. A.

Stayton, Edward M. Maj., U. S. A., 110th Engrs.

Stearns, Fred LeRoy. Lieut., U. S. A., Co. A, 107th Inf.

Stearns, Ralph H. Lieut. (Junior Grade), U. S. N. R. F.

Steep, James B. Capt., Engineers, U. S. A.

Steese, James Gordon. Col., Engineers, U. S. A., General Staff.

Steeves, C. McN. Lieut., 9th Field Co., Canadian Engrs., B. E. F., France.

Steinhauser, H. H. 2d Lieut., Air Service, U. S. A. (Aeronautics); Engr. Officer, 346th Handley-Page Service Squadron.

Stellhorn, Adolf. Capt., Engineers, U. S. A., Office, Chf. Engr., S. O. R., P. O. 717, A. E. F., France.

Stem, Clifford H. 1st Lieut., Engineers, U. S. A., 101st and 2d Engrs., A. E. F., France.

Stephens, Uel. Capt., Infantry, U. S. A., Co. D, 57th Inf.

Stern, Eugene W. Maj., Engineers, U. S. A.; Supt. of Roads, Care, C. G. Base Section No. 2, U. S. Military P. O. 705, A. E. F., France.

Stevenson, Markley. Ensign, U. S. N. R. F.

Stewart, Benjamin F., Jr. 1st Lieut., Engineers, U. S. A.

Stewart, John. Lt.-Col., U. S. A., 323d Engrs.

Stewart, John T. Maj., Engineers, U. S. A.

Stewart, Spencer J. Capt., Quartermaster Corps, U. S. A., Constr. Div.

Stickle, H. W. Lt.-Col., U. S. A. (*Retired*).

Stidham, Harrison. Capt., Quartermaster Corps, U. S. A., Constr. Div.

Stillwell, Howard L. 2d Lieut., Quartermaster Corps, U. S. A.

Stineman, Norman M. Capt., Engineers, U. S. A., Co. D, 33d Engrs., A. E. F., France.

Stivers, A. D. Capt., Infantry, U. S. A.

Stocker, Leslie W. 1st Lieut., Engineers, U. S. A.

Storey, Franklin S. 1st Lieut., Engineers, U. S. A., A. E. F., France.

Stowe, H. D. Capt., Engineers, U. S. A.

Strachan, Joseph J. Lieut. (Junior Grade), Civil Engineer Corps, U. S. N.

Strachan, Norman F. Private, 23d Engrs.

Strecker, R. A. Maj., Engineer, U. S. A., 2d Bn., 309th Engrs., A. E. F., France.

Street, J. Z. Private, Specialist Detachment, Co. A, 26th Engrs., A. E. F., France.

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Strickler, G. B. Lt.-Col., Quartermaster Corps, U. S. A.

Strickler, T. J. Capt., Engineers, U. S. A.

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Stuart, Edward. Capt., Sanitary Corps, U. S. A.

Stupp, John G. 1st Lieut., C. W. S., U. S. A.

Sturtevant, C. W. Lt.-Col., U. S. A., 15th Engrs., A. E. F., France.

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Summers, R. E. J. 1st Lieut., Engineers, U. S. A., Co. F, 15th Engrs. (Ry.), A. E. F., France.

Suter, Charles R. Brig.-Gen., U. S. A. (*Retired*).

Suter, Russell. Capt., Engineers, U. S. A., Care, S. E. O., Int. Sect., S. O. S., A. E. F., France.

Sutton, Frank. Maj., Engineers, U. S. A., 29th Engrs.

Swaren, J. W. Maj., Engineers, U. S. A.,

Swartz, Leon. Master Engr., 15th U. S. Engrs., A. E. F., France.

Sweeney, Harry C. Capt., Quartermaster Corps, U. S. A.

Sweetser, C. H. Capt., Engineers, U. S. A., Co. A, 43d Engrs., A. E. F., France.

Sweetser, E. O. Capt., Engineers, U. S. A. (*Unattached*), A. E. F., France.

Swett, Everett H. Capt., Engineers, U. S. A.

Sykes, George. Capt., Engineers, U. S. A., A. E. F., France.

Symonds, G. R. B. Capt., Engineers, U. S. A., Co. A, 605th Engrs.

Tainter, F. S. Maj., Engineers, U. S. A.

Talbot, K. H. Capt., Quartermaster Corps, U. S. A.

Tandrow, Walter S. 1st Lieut., Engineers, U. S. A.

Tate, R. L. Capt., Engineers, U. S. A.; Adjt., 1st Bn., 303d Engrs., A. E. F., France.

Taussig, John Wright. Private, E. O. T. S., Co. I, Camp Humphreys, Va.

Tay, S. W. Lieut., U. S. N. N. V., U. S. S. *Wenonah.*

Taylor, Arthur. Capt., Engineers, U. S. A.

Taylor, Edwin A. Maj., Engineers, U. S. A., 526th Engrs., A. E. F., France.

Taylor, Harry. Brig.-Gen., U. S. A.

Taylor, Henry. Capt., Engineers, U. S. A., 304th Engrs.

Taylor, Hugh M. Maj., U. S. A., Care, D. G. T., A. P. O. 762, A. E. F., France.

Taylor, Nelson. Lieut., U. S. N., U. S. S. *Bridgeport.*

Taylor, P. M. 2d Lieut., R. E., 237th Field Co., B. E. F., Italy.

Taylor, Seneca V. Capt., Coast Artillery, U. S. A.

Taylor, William T. Capt., Royal Flying Corps, B. E. F., France.

Taylor, Wyllys H. Capt., Engineers, U. S. A., 306th Engrs.

Ten Hagen, Henry. 2d Lieut., Engineers, U. S. A., 303d Engrs.

Tenney, Willis R. Capt., Engineers, U. S. A., Eng. Depot, U. S. A. P. O. 712, A. E. F., France.

Thomas, Charles D. Capt., Engineers, U. S. A., Co. B, 507th Engrs., A. E. F., France.

Thomas, W. E. Capt., Constr. Div., Quartermaster Corps, U. S. A.

Thomas, William Michael. Capt., Engineers, U. S. A.

Thompson, James A. 2d Lieut., Coast Artillery, U. S. A.

Thompson, Sanford E. Maj., Engineers, U. S. A.

Thompson, Wilford Ashford. 1st Lieut., U. S. A., 4th Engr. Tr. Regt., Camp Humphreys, Va.

Thomsen, S. L. Capt., Engineers, U. S. A., Co. A, 57th Engrs., A. E. F., France.

Thomson, F. M. Capt., U. S. A., 39th Engrs., A. E. F., France.

Thornton, L. Earle. Lieut., Civil Engineer Corps, U. S. N. R. F., U. S. N. S., Le Croisic, France.

Throop, George H. Capt., Engineers, U. S. A., Co. E, 24th Engrs.

Thurber, Clinton D. Commander, Civil Engineer Corps, U. S. N.

Thurston, Eugene T. Capt., Engineers, U. S. A.

Tilden, Charles Joseph. Capt., Engineers, U. S. A. (*Unassigned*).

Tinkham, Ralph R. Capt., Engineers, U. S. A., 420th Engrs.

Tinsley, R. B. Capt., Engineers, U. S. A., Co. C, 605th Engrs., A. E. F., France.

Tirrell, Charles Edwards. Signal Corps, Aviation Section (Non-Flying), U. S. A.

Todd, Frank Herbert. Maj., Quartermaster Corps, U. S. A.

Todd, Oliver J. Capt., Engineers, U. S. A., A. P. O. No. 780, A. E. F., France.

Tolles, F. C. 1st Lieut., Engineers, U. S. A., 112th Engrs.

Tomlinson, Alfred Thomas. Maj., Canadian Engrs.; Insp. Small Arms Ammunition, Dominion Arsenal, Lindsay, Ont., Canada.

Tompkins, Robert Harry. 1st Lieut., U. S. A., 111th Engrs., A. E. F., France.

Topping, Perry. Capt., Engineers, U. S. A., 5th Engrs.

Torrance, William M. Capt., Engineers, U. S. A.

Townsend, C. McD. Col., Engineers, U. S. A., 12th Engrs. (Ry.), A. E. F., France.

Toyne, John Wilson. Capt., Quartermaster Corps, U. S. A.

Tracy, C. C. Capt., Coast Artillery, U. S. A.

Tracy, Herbert Herman. 1st Lieut., Engineers, U. S. A., Engr. Wagon Co. 4, 23d Engrs., U. S. A. P. O. 708, A. E. F., France.

Travers-Ewell, Andrew. Capt., Care, Gibbs & Co., Antofagasta, Chile.

Treser, Albert Paul. 605th Engrs., A. E. F., France.

Trimpi, Allan Littell. 1st Lieut., U. S. A., 104th Engrs.

Trout, Alexander Linn. Capt., Engineers, U. S. A. (*Unassigned*), A. E. F., France.

True, Albert O. Capt., Engineers, U. S. A.

Trueblood, P. McG. Lieut., U. S. N. R. F.

Tucker, H. F. Ensign, U. S. N. R. F.

Turley, Jay. Capt., Engineers, U. S. A., Care, Eng. Purchasing Officer, P. O. No. 702, A. E. F., France.

Turner, Daniel Norman. 2d Lieut., Engineers, U. S. A., 304th Engrs.

Turner, Nathaniel Parker. Capt., U. S. A., Co. B, 111th Engrs., A. E. F., France.

Tuska, Gustave R. Maj., Engineers, U. S. A.

Tyler, Richard G. Capt., Quartermaster Corps, U. S. A.

Tyson, William C. Capt., Engineers, U. S. A., Co. No. 2, Camp Custer Replacement Draft, A. E. F., France.

Uhler, W. D. Lt.-Col., Quartermaster Corps, U. S. A.

Van Amburgh, Thomas A. 1st Lieut., Quartermaster Corps, U. S. A.

Van Buren, Maurice Pelham. Capt., Engineers, U. S. A., 602d Engrs.

Vandemoer, John Jay. Capt., U. S. A., 467th Engrs., A. E. F., France.

Vandemoer, N. C. Capt., Engineers, U. S. A.

Vanderhoof, Arnold H. Lieut., U. S. N. (*Retired*), Radio Div., Bureau of Steam Eng.

Vandervoort, B. F. Capt., Engineers, U. S. A.

Vandevanter, Elliott. Capt., Engineers, U. S. A., Co. D, 503d Engrs., A. E. F., France.

Van Ness, R. A. Lieut., Engineers, U. S. A.

Van Pelt, Sutton. Capt., Engineers, U. S. A., 110th Engrs.

Van Suetendael, Achille O. Capt., Engineers, U. S. A.

Van Zile, Harry Lee. Maj., Engineers, U. S. A., Office, D. of C. and F., S. O. S., A. E. F., France.

Vaughan, Henry F. Capt., Sanitary Corps, U. S. A.

Vernon, Stephen B. Capt., Engineers, U. S. A. (*Unassigned*).

Verrill, George E. Maj., Engineers, U. S. A.

Vincent, J. I. Capt., Ordnance, U. S. A.

Vincent, W. H. 1st Lieut., Engineers, U. S. A.

Vogdes, Joseph J. Capt., Railroad Transportation Corps, U. S. A., Care, D. G. T., A. E. F., France.

Vogleson, J. A. Maj., Sanitary Corps, U. S. A.

Volk, Wendell Douglas. Capt., Engineers, U. S. A.

von Deesten, A. P. Maj., Engineers, U. S. A.

Wade, George W. 1st Lieut., Co. D, 2d Bn., 117th Engrs., 42d Div., A. E. F., France.

Wadsworth, George R. Maj., Signal Corps, U. S. A.

Wadsworth, Henry H. Maj., Engineers, U. S. A.

Wagner, John, Jr. 1st Lieut., Cavalry, U. S. A., First Corps School, Army P. O. No. 703, A. E. F., France.

Waite, Clement F. 1st Lieut., Engineers, U. S. A.

Waite, H. M. Lt.-Col., Railroad Transportation Corps, U. S. A., Care, Railroad Transportation Corps, A. E. F., France.

Waldron, Albert E. Col., U. S. A., 35th Engrs., A. E. F., France.

Walker, Edward G. Lieut., R. N. V. R.; 78 Cheyne Court, Chelsea, London, S. W. 3, England.

Walker, Elton D. Capt., Engineers, U. S. A., Co. A, 5th Engrs., A. E. F., France.

Walker, Harry Bruce. Capt., Engineers, U. S. A.

Walker, Meriwether Lewis. Col., Engineers, U. S. A., G. H. Q., A. E. F., France.

Walker, W. Kemp. Capt., Engineers, U. S. A.

Wallace, David A. Capt., Engineers, U. S. A., Headquarters, Director General of Transportation, A. P. O. 717, A. E. F., France.

Wallace, Harold U. Maj., Engineers, U. S. A.

Waller, Alexander C. 1st Lieut., Engineers, U. S. A., 22d Engrs., A. E. F., France.

Waller, Percy. Capt., Engineers, U. S. A.

Walter, Frank E. 1st Lieut., Co. B, 55th Engrs., A. E. F., France.

Walton, H. B. Capt., Engineers, U. S. A., 312th Engrs.

Wand, A. W. Lieut., Engineers, U. S. A.

Wanzer, James O. 1st Lieut., U. S. A., 47th Engrs., A. E. F., France.

Ward, George S. 2d Lieut., Engineers, U. S. A., Co. A, 117th Engrs., A. E. F., France.

Ward, Jasper D. 1st Lieut., Infantry, U. S. A.

Ward, Lyman Wise. Capt., Coast Artillery, U. S. A.; Adjt., 1st Bn., 63d Artillery.

Ware, Howard T. 2d Lieut., Quartermaster Corps, U. S. A., Bakery Co. No. 317.

Ware, John. 1st Lieut., Co. A, 101st Engrs., A. E. F., France.

Ware, Norton. Capt., Engineers, U. S. A.

Warfield, Ralph M. Lt.-Commander, Civil Engineer Corps, U. S. N.

Waring, C. T. Maj., Signal Corps, U. S. A., Headquarters, Aircraft Acceptance Park No. 2, 35 Eaton Pl., London, S. W. 1, England.

Warner, Elwin S. Capt., Engineers, U. S. A., Co. B, 301st Engrs.

Warnock, W. H. Capt., Quartermaster Corps, U. S. A.

Warren, Horace P. Maj., U. S. A., 55th Engrs., A. E. F., France.

Warren, James G. Col., Engineers, U. S. A.

Warren, Minton M. 1st Lieut., Engineers, U. S. A., Headquarters Co., 101st Engrs., 51st Brigade, 26th Div., A. E. F., France.

Warren, Philip R. Maj., Royal Engrs., P. C. E., A. P. O. S. 10, B. E. F., France.

Waterman, Earle L. 1st Lieut., Sanitary Corps, U. S. A.

Watkins, Guy A. Capt., Engineers, U. S. A.

Watson, D. M. Lieut., M. T., A. S. C., 100th Siege Battery, R. G. A., B. E. F., France.

Watson, George L. Lt.-Col., Engineers, U. S. A., General Staff, C. A. C. of S. G. 2, 1st Army Corps, A. E. F., France.

Watson, Loyall F. 1st Lieut., U. S. A., 403d Engrs.

Watson, Winslow B. 1st Lieut., U. S. A., 106th Inf.

Watt, David A. Maj., Engineers, U. S. A.

Waugh, William H. Maj., Engineers, U. S. A.

Way, W. F. 2d Lieut., Co. D, 18th Engrs. (Ry.), U. S. Army Post Office No. 705, A. E. F., France.

Weaver, C. J. 1st Lieut., Engineers, U. S. A.

Weaver, Earll Chase. Asst. Civ. Engr., U. S. N. R. F.

Weaver, Frank L. Capt., Engineers, U. S. A., 305th Engrs.

Webb, Claude A. 2d Lieut., Field Artillery, U. S. A., 121st F. A., A. E. F., France.

Webb, De Witt Clinton. Commander, Civil Engineer Corps, U. S. N.

Webb, George H. Lt.-Col., 16th U. S. Engrs. (Ry.), A. E. F., France.

Webb, I. Gano. Capt., Engineers, U. S. A.

Webb, Walter Loring. Maj., Engineers, U. S. A., A. E. F., France.

Webster, Maurice A. Capt., Ordnance, U. S. A.

Weeks, W. C. Maj., Engineers, U. S. A., 32d Engrs., Care, Y. M. C. A. Hotel for Officers, Paris, France.

Welden, Ernest. Private, Co. A, 43d Engrs., A. E. F., France.

Welles, Theodore L., Jr. 2d Lieut., Engineers, U. S. A.

Wells, Emery. 1st Lieut., Engineers, U. S. A., A. P. O. 712, A. E. F., France.

Welsh, Russell D. Private, Co. F, 115th Engrs., A. E. F., France.

Wenige, Arthur E. Maj., Engineers, U. S. A., 317th Engrs.

Wenzell, Andrew P. Capt., Co. F, 16th U. S. Engrs. (Ry.), A. E. F., France.

West, Edward Hazzard. Capt., Engineers, U. S. A., 5th Engrs.

West, Wade C. Capt., Engineers, U. S. A.

Wheat, G. Neville. Capt., Engineers, U. S. A.

Wheeler, Edgar True. Capt., U. S. A., 125th Engrs.

Wheeler, Frank I. 2d Lieut., Aviation Section, Signal Corps, U. S. A.

Wheeler, Robert C. Capt., Quartermaster Corps, U. S. A.

Wheelock, De Forest A. Col., U. S. A.

Whiteaker, Robert O. Capt., U. S. A., 132d F. A.

Whitman, Ezra B. Maj., Quartermaster Corps, U. S. A.

Whitman, Ralph. Lt.-Commander, Civil Engineer Corps, U. S. N.

Whitney, C. S. Corporal, Co. F, 25th Engrs., A. P. O. 705, A. E. F., France.

Whitney, John T. 2d Lieut., Field Artillery, U. S. A., 2d Corps Artillery Park, A. E. F., France.

Whitney, Ralph Edward. 1st Lieut., Sanitary Corps, U. S. A.

Whitsit, Lyle A. Capt., Engineers, U. S. A.

Whitwell, E. Capt., General Service Staff, British War Office, Robert Treat Hotel, Newark, N. J.

Wickersham, John H. Lt.-Col., Engineers, U. S. A.; Deputy Engr. Supply Officer, General Headquarters, P. O. 706, A. E. F., France.

Widdicombe, R. A. Maj., Engineers, U. S. A.

Widdicombe, Stacey H. U. S. S. M. A., Princeton, N. J.

Wiggin, Thomas H. Capt., Engineers, U. S. A., Headquarters, Lines of Communications, A. E. F., France.

Wiggins, Ralph Raymond. 1st Lieut., Aviation Section, Signal Corps, U. S. A.

Wilcox, Ernest Hardwick. Capt., Engineers, U. S. A., 543d Engrs., A. E. F., France.

Wild, H. J. Maj., Engineers, U. S. A.

Wildish, Frederic Newton. Capt., Engineers, U. S. A., Co. B, 309th Engrs.

Wilgus, H. S. Maj., Engineers, U. S. A.

Wilgus, W. J. Col., Engineers, U. S. A., A. E. F., France.

Willard, George T. Private, Co. E, 318th Engrs.

Willard, N. R. Capt., Engineers, U. S. A.

Willcomb, George E. Capt., Quartermaster Corps, U. S. A.

Willcox, Henry. Capt., Quartermaster Corps, U. S. A., Constr. Div.

Williams, Alan F. 2d Lieut., Co. B, 18th Engrs. (Ry.), U. S. Army P. O. No. 705, A. E. F., France.

Williams, George D. Capt., Engineers, U. S. A., Co. H, 548th Engrs., A. E. F., France.

Williams, Samuel W. Maj., Engineers, U. S. A.

Williamson, Harry. Capt., Royal Engrs.; O. C. 272d Ry. Constr. Co., R. E., E. E. F., Egypt.

Williamson, Lee H. 2d Lieut., Engineers, U. S. A., Co. A, 55th Engrs.

Williamson, Sydney B. Lt.-Col., Engineers, U. S. A.

Williar, Harry D., Jr. Maj., U. S. A., 1st Engrs., A. E. F., France.

Willis, Walter John. Lieut. (EDO).

Wilson, Edbert C. Capt., Engineers, U. S. A.

Wilson, Everitt W. Capt., Engineers, U. S. A., Co. A, 304th Engrs.

Wilson, Harry P. Capt., Engineers, U. S. A., 310th Engrs.

Wilson, Louis A. Capt., U. S. A., 417th Engrs.

Wilson, Norman K. 2d Lieut., 473d Aero Squadron, Care, U. S. Air Service, 35 Eaton Pl., London, England.

Wilson, Robert B. M. Capt., Engineers, U. S. A., 311th Engrs.

Wilson, William R. Maj., 23d Field Co., R. E., B. E. F., France.

Winchester, T. H. Lieut., Engineers, U. S. A.

Wing, Charles B. Maj., Engineers, U. S. A., 23d Engrs., A. P. O. 738, A. E. F., France.

Winn, Walter E. Lt.-Col., Engineers, U. S. A., 114th Engrs., A. E. F., France.

Winn, Walter S. Maj., Engineers, U. S. A.

Winton, Walter Ferrell. Capt., Field Artillery, U. S. A., 14th F. A.

Wodrich, Oscar F. Capt., Quartermaster Corps, U. S. A.

Wolff, H. H. Capt., Engineers, U. S. A., 556th Engr. Service Bn.

Wood, B. Russell. Capt., Engineers, U. S. A. (*Unassigned*), U. S. M. P. O. 733, A. E. F., France.

Wood, Frederic J. Maj., Engineers, U. S. A.

Woodard, Wilkie. Capt., Engineers, U. S. A., Co. H, 35th Engrs., A. P. O. 735, A. E. F., France.

Woodle, Bernon Tisdale. Capt., Engineers, U. S. A.

Woodruff, Charles W. 1st Lieut., U. S. A., 403d Engrs.

Woodruff, Glenn B. 1st Lieut., Engineers, U. S. A.

Woodward, Edwin C. Capt., U. S. A., 22d Engrs., A. E. F., France.

Woodward, Frank C. 1st Lieut., Engineers, U. S. A.

Woolworth, W. H. Capt., U. S. A., Headquarters, 2d Brigade, 1st Div., A. E. F., France.

Wooten, William P. Col., Engineers, U. S. A., Headquarters, 3d Corps, A. E. F., France.

Wright, Edward. Capt., Sanitary Corps, U. S. A.

Wright, Jesse B. Capt., Engineers, U. S. A.

Wright, John Bertram. Capt., Engineers, U. S. A.

Wrightson, William D. Maj., Sanitary Corps, U. S A.; Chf. of San. Corps, U. S. A.

Yates, Sheldon S. Field Artillery Officers' Training Camp, Camp Zachary Taylor, Ky.

Yeo, W. H. W. Capt., Engineers, U. S. A.

Yereance, Alex. W. 1st Lieut., Co. F, 305th Engrs., A. E. F., France.

Yost, Howard McC. Maj., Engineers, U. S. A.

Young, Frederick C. Capt., Engineers, U. S. A.; Adjt., 114th Engrs.

Young, George S. Capt., Engineers, U. S. A., G-2-C, A. P. O. 784, A. E. F., France.

Young, Samuel M. Capt., Engineers, U. S. A.

Zinn, George A. Col., Engineers, U. S. A.

MEMBERSHIP

(From November 8th to December 5th, 1918)

ADDITIONS

MEMBERS		Date of Membership.
COY, BURGIS GREENACRE. Capt., Engrs., U. S. A., Co. D, 314th Engrs., Am. Exp. Forces, France; Address, 103 North Sherwood St., Fort Collins, Colo	Assoc. M. M.	April 4, 1911 Nov. 26, 1918
EMBURY, AYMAR, 2D. Capt., Engrs., U. S. A., Camouflage Section, Am. Exp. Forces, France	Assoc. M. M.	Nov. 28, 1916 Sept. 10, 1918
FARWELL, CARROLL ANDREW. Engr., Fay, Spofford & Thorndike, 308 Boylston St., Boston, Mass	Assoc. M. M.	Jan. 31, 1911 Nov. 26, 1918
FURLOW, FELDER. Capt., Engrs., U. S. A., Headquarters, West Cantonment, Fort Benjamin Harrison, Ind	Assoc. M. M.	April 6, 1909 Nov. 26, 1918
GUISE, PHILIP. Dock Engr., Mason & Hanger Co., Charleston Port Terminal, U. S. Army Base, Charleston, S. C	Assoc. M. M.	Nov. 6, 1907 Nov. 26, 1918
HAWLEY, CHARLES BURRIDGE. Prin. Asst. Hydr. Engr., The Aluminum Co. of America, 2426 Oliver Bldg., Pittsburgh, Pa	Jun. M.	May 4, 1909 Nov. 26, 1918
HILL, GEORGE HAMMEKEN. Ninth Div. Engr., State Road Comm., 311 Broad St., Charleston, W. Va		Oct. 8, 1918
HUNT, ARON LANCASTER. Insp., Marine Ry., U. S. Shipping Board, Dist. No. 4, 411 West Church St., Jacksonville, Fla		Nov. 26, 1918
JACOBOSKY, GILBERT GARFIELD. Capt., Engrs., U. S. A., Headquarters, 1st Bn., 55th Engrs., A. P. O. 738, Am. Exp. Forces, France (Res., 211 South Main St., Wilkes-Barre, Pa.)	Jun. Assoc. M. M.	Nov. 5, 1907 June 6, 1911 June 19, 1918
NEWTON, ERNEST JAMES. Contr. Engr., King Bridge Co., 10830 Massie Ave., N. E., Cleveland, Ohio		Nov. 26, 1918
PENDLEBURY, EDWARD. Engr., Contr. Dept., Salmond Bros. Co., 526 Elm St. (Res., 26 Franklin St.), Arlington, N. J	Jun. Assoc. M. M.	Oct. 2, 1906 April 5, 1910 Nov. 26, 1918
ROOT, JOSEPH EUGENE. Sewerage Engr., Div. of Sewerage, Dept. of Public Service, Delaware Bldg., Akron, Ohio	Assoc. M. M.	Dec. 3, 1913 Nov. 26, 1918
SENIOR, FRANK SEARS. Maj., R. T. C., U. S. A., Care, Director-General of Transportation, A. P. O. 717, Am. Exp. Forces, France; Vice-Pres., Arthur McMullen Co., Montgomery, N. Y	Jun. Assoc. M. M.	Feb. 28, 1899 Feb. 5, 1908 Sept. 10, 1918

MEMBERS (*Continued*)

		Date of Membership.
SHARTS, STANLEY RUSH. County Engr., Dayton, Ohio	Assoc. M. M.	Dec. 6, 1915 Nov. 26, 1918
SPARROW, WILLIAM WARBURTON KNOX. Corporate Chf. Engr., C., M. & St. P. R. R., 1527 Railway Exchange Bldg., Chicago, Ill.	Assoc. M. M.	Dec. 6, 1905 Nov. 26, 1918
TOMPKINS, CHARLES HOOK. Civ. Engr. and Contr., 1883 Third St., N. W., Washington, D. C	Assoc. M. M.	Dec. 6, 1910 Nov. 26, 1918
VAN ZILE, HARRY LEE. Maj., Engrs., U. S. A., Office, D. of C. and F., S. O. S., Am. Exp. Forces, France; Pres., Van Zile Ventilating Corporation, 39 Cortlandt St., New York City	Jun. M.	Jan. 6, 1886 Oct. 8, 1918

ASSOCIATE MEMBERS

BAPTISTE, ELMER ELLSWORTH. Draftsman and Engr., A. J. Corcoran, Inc., 256 Palisade Ave., Jersey City, N. J.		Nov. 26, 1918
BROWN, GEORGE HERMAN. Res. Engr., Robert W. Hunt & Co., Box 553, Beardstown, Ill.		Nov. 26, 1918
CLAAR, RUFUS SAMUEL. Office, Engr., D., S. S. & A. Ry., 904 Fidelity Bldg., Duluth, Minn.		Oct. 8, 1918
CONNOLLY, DONALD HILARY. Lt.-Col., Engrs., U. S. A., Office, Chf. of Staff, U. S. A., Washington, D. C	Jun. Assoc. M.	April 7, 1915 Oct. 8, 1918
DEMMERT, HOWARD HENRY. Vice-Pres. and Chf. Engr., The Eastern Paving Co., 1847 Wynnewood Rd., Overbrook, Philadelphia, Pa		Nov. 26, 1918
GANTT, JAMES JERVEY. Asst. Engr., So. Ry., P. O. Box 267, Toccoa, Ga		Nov. 26, 1918
HAMMER, EDMOND WALTER. Gen. Supt., Tidewater Bldg. Co., Yorkship Village, Camden, N. J		Nov. 26, 1918
HANSEN, CARL VALDEMAR. Chf. Engr., St. John Levee and Drainage Dist. of Missouri, New Madrid, Mo		Nov. 26, 1918
HEMPEL, ROY EDWARD. County Surv., Trumbull County, and Res. Engr., State Highway Dept., Court House, Warren, Ohio		Nov. 26, 1918
HERMESSEN, JOHN LOUIS. Asst. Insp., British War Mission, 615 Union Central Bldg., Cincinnati, Ohio		Nov. 26, 1918
HOLLMAN, JOHN GEORGE. Capt., Engrs., U. S. A., Base Section No. 4, Am. Exp. Forces, France; Address, Shiner, Tex		Sept. 10, 1918
INGALLS, JAMES WARREN. Asst. Engr., Maine Cent. R. R., Portland, Me	Jun. Assoc. M.	Mar. 4, 1913 Nov. 26, 1918

ASSOCIATE MEMBERS (*Continued*)

		Date of Membership.
Jones, Harvey Willard. Capt., Q. M. C., U. S. A.; Acting Utilities Officer, Camp Lee, Va.		Mar. 12, 1918
Koch, Edward Louis. Superv., W. J. & S. R. R., 427 Pearl St., Camden, N. J.		Nov. 26, 1918
Lass, Charles Abraham. Engr., Birmingham Ry., Light & Power Co., Birmingham, Ala.		Nov. 26, 1918
Leech, James Harold. Asst. Supervisor of Constr., Aluminum Castings Co., 1878 Marloes St., East Cleveland, Ohio		Nov. 26, 1918
Macbeth, James Alexander Duff. Care, John S. Metcalf Co., Ltd., National Mutual Bldgs., Melbourne, Victoria, Australia		May 13, 1918
McChesney, Mortimer Johnson. City Mgr., 411 Ruffner Ave., Charleston, W. Va.		Nov. 26, 1918
Mitchell, Frank Livingston. Asst. Gen. Mgr., The Barahona Co., Inc., Barahona, Dominican Republic		Oct. 8, 1918
Newbold, Richard Claxton. Designing Sales Engr., Philadelphia Office, Trussed Concrete Steel Co., 200 Poplar Ave., Wayne, Pa.		Nov. 26, 1918
Ogden, Merton Miles. 1st Lieut., Engrs., U. S. A., Co. D, 33d Engrs., A. P. O. 708, Am. Exp. Forces, France	Jun. Assoc. M.	Oct. 7, 1914 Nov. 26, 1918
Ohrt, Frederick. 4 Chauncy St., Cambridge, Mass.	Jun. Assoc. M.	Feb. 6, 1912 Oct. 8, 1918
Pendleton, Thomas Percy. Lieut., Engrs., U. S. A., Care, U. S. Geological Survey, Washington, D. C.		Nov. 26, 1918
Potts, Wilmer Houston. Supt., Materials, Air Nitrates Corporation, P. O. Box 294, Muscle Shoals, Ala.		June 18, 1918
Prack, Arthur Edward. Mgr., Canadian Work, with Bernard H. Prack, 808 Lumsden Bldg., Toronto, Ont., Canada	Jun. Assoc. M.	Nov. 28, 1916 Nov. 26, 1918
Sandstedt, Carl Edward. Asst. Engr., C., M. & St. P. Ry., 22 Milwaukee Depot, Minneapolis, Minn.	Jun. Assoc. M.	June 4, 1913 Sept. 10, 1918
Searight, George Peter. 1st Lieut., Engrs., U. S. A., Co. B, 27th Engrs., Am. Exp. Forces, France (Res., 5 East Louther St., Carlisle, Pa.)	Jun. Assoc. M.	Nov. 1, 1910 Nov. 26, 1918
Slade, John Rhodes. 1344 Second Ave., Columbus, Ga.		Oct. 8, 1918
Stalfort, John Alfred. Gen. Mgr., Bldg. Dept., Consolidated Eng. Co., 243 Calvert Bldg., Baltimore, Md.		Nov. 26, 1918
Starks, William Frederic. County Supt. of Highways, Nassau County, Glen Cove, N. Y.		Nov. 26, 1918
Stieve, William Matthew. Ship Draftsman, U. S. Navy Dept., 810 Taylor St., N. W., Washington, D. C.	Jun. Assoc. M.	June 30, 1911 Nov. 26, 1918

ASSOCIATE MEMBERS (*Continued*)

		Date of Membership.
STOW, FREDERIC STEVENS. Asst. Gen. Supt., The Baker-Dunbar-Allen Co., 437 Union Arcade, Pittsburgh, Pa...................	Jun. Assoc. M.	Sept. 3, 1912 Nov. 26, 1918
THORN, HARRY BELMONTE. Eng. Div. Head, Constr. Dept., Braden Copper Co., 120 Broadway, New York City..		Nov. 26, 1918
WEBB, DANIEL JOHN HENRY. Engr. and Supt., Franklin Contr. Co., P. O. Box 879, New Haven, Conn........		Nov. 26, 1918
WILLIAMS, JOHN ALONZO. Asst. Div. Engr., New Jersey State Highway Dept., 1169 Kenwood Ave., Camden, N. J....................................		Nov. 26, 1918

ASSOCIATES

REYNOLDS, FRANK LOUIS. Estimator and Designing Engr., George A. Fuller Co., Care, New Orleans Army Supply Depot, 823 Poland St., New Orleans, La............	Nov. 26, 1918

JUNIORS

APESECHE, OVIDIO BENEDICTO. Road Engr., Care, E. Rossi, 549 South Division St., Ann Arbor, Mich............	Nov. 26, 1918
CLARK, CHARLES ARMSTRONG. Field Engr., Portland Cement Assoc., 310 Rialto Bldg., Kansas City, Mo..........	Nov. 26, 1918
CRANCH, EUGENE THOMPSON. Acting Res. Engr., Hoad & Decker, 813 Sassafras St., Erie, Pa................	Nov. 26, 1918
CUNLIFF, CHARLES, JR. Lieut., U. S. A., 403d Engrs., Fort Douglas, Utah (Res., 15 Windermere Pl., St. Louis, Mo.)	Sept. 10, 1918

CHANGES OF ADDRESS

MEMBERS

BALCH, WILLIAM HOYT. Maj., Engrs., U. S. A., A. P. O. 717, Am. Exp. Forces, France.

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PIERCE, CHARLES WILLIAM. Ensign, C. E. C., U. S. N., U. S. S. *Pittsburgh*, Care, Postmaster, New York City; Address, 1122 West 8th St., Los Angeles, Cal.

RICHARDS, GEORGE WILLIAM. 1530 Frick Bldg., Pittsburgh, Pa.

SMITH, RICHARD BENNETT. Private, Meteorological Section, Sig. C., U. S. A., Am. Exp. Forces, France; Address, Care, Mrs. W. Y. Smith, Vienna, Ill.

TRUESDELL, STEPHEN RIGGS. Bridge Dept., C. & N. W. Ry., 1830 Sheridan Rd., Evanston, Ill.

REINSTATEMENTS

ASSOCIATE MEMBERS

	Date of Reinstatement.
HAWLEY, CHARLES RAY	Oct. 8, 1918

DEATHS

ALEXANDER, EDWARD PORTER. Elected Junior, November 4th, 1914; died in service (France), September 5th, 1918.

BOWIE, AUGUSTUS JESSE. Elected Member, November 1st, 1882; died May 20th, 1917.

COLEMAN, CLARENCE. Elected Member, November 3d, 1897; died October 23d, 1918.

DEAN, STANLEY. Elected Associate Member, April 1st, 1908; died in service (Camp Humphreys, Va.), October 2d, 1918.

DEDICKE, ERNEST CHARLES. Elected Junior, November 28th, 1916; wounded in action (France); died July 15th, 1918.

GEIGER, ALBERT FRANCIS. Elected Associate Member, March 12th, 1918; died November 3d, 1918.

HALLOCK, JAMES CURRIE. Elected Member, October 3d, 1906; died November 2d, 1918.

LYDON, WILLIAM ANTHONY. Elected Junior, January 4th, 1888; Member, December 5th, 1894; died October 28th, 1918.

MCCLURE, GUY VINCENT. Elected Associate Member, April 4th, 1911; died October 23d, 1918.

MCCLURE, HUNTER. Elected Junior, January 4th, 1910; Associate Member, October 9th, 1917; died in service (France), September 26th, 1918.

MONCURE, WILLIAM AUGUSTUS. Elected Junior, June 21st, 1894; Associate Member, October 7th, 1896; Member, June 5th, 1906; died October 3d, 1918.

MORRIS, CHARLES JOHN AUGUSTUS. Elected Member, October 3d, 1883; died October 27th, 1918.

POTTER, EDWIN JAMES. Elected Junior, October 1st, 1907; Associate Member, October 1st, 1913; died October 18th, 1918.

REAM, WARD HALL. Elected Associate Member, April 18th, 1916; killed in action (France), October 4th, 1918.

ROBINSON, ALBERT ALONZO. Elected Member, May 5th, 1880; died November 7th, 1918.

SIDENIUS, HARRY. Elected Associate Member, January 2d, 1912; Member, June 24th, 1914; died November 7th, 1918.

SMITH, EDGAR FIELD. Elected Associate Member, May 1st, 1907; date of death unknown.

UPSON, WARREN WILLIAM. Elected Associate Member, May 31st, 1916; died September 2d, 1918.

Total Membership of the Society, December 5th, 1918, 8 937.

MONTHLY LIST OF RECENT ENGINEERING ARTICLES OF INTEREST

(November 1st to December 2d, 1918)

NOTE.—*This list is published for the purpose of placing before the members of this Society, the titles of current engineering articles, which can be referred to in any available engineering library, or can be procured by addressing the publication directly, the address and price being given wherever possible.*

LIST OF PUBLICATIONS

In the subjoined list of articles, references are given by the number prefixed to each journal in this list:

(2) *Journal,* Engrs. Club of Phila., Philadelphia, Pa.
(3) *Journal,* Franklin Inst., Philadelphia, Pa., 50c.
(4) *Journal,* Western Soc. of Engrs., Chicago, Ill., 50c.
(5) *Journal,* Eng. Inst. of Canada, Montreal, Que., Canada.
(6) *Journal,* Am. Inst. of Archts., Washington, D. C., 50c.
(8) *Stevens Indicator,* Hoboken, N. J., 50c.
(9) *Industrial Management,* New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, 432 Fourth Ave., New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News-Record,* New York City, 15c.
(15) *Railway Age,* New York City, 15c.
(16) *Engineering and Mining Journal,* New York City, 15c.
(17) *Electric Railway Journal,* New York City, 10c.
(18) *Railway Review,* Chicago, Ill., 15c.
(19) *Scientific American Supplement,* New York City, 10c.
(20) *Iron Age,* New York City, 20c.
(21) *Railway Engineer,* London, England, 1s. 2d.
(22) *Iron and Coal Trades Review,* London, England, 6d.
(24) *American Gas Engineering Journal,* New York City, 10c.
(25) *Railway Mechanical Engineer,* New York City, 20c.
(26) *Electrical Review,* London, England, 4d.
(27) *Electrical World,* New York City, 10c.
(28) *Journal,* New England Water-Works Assoc., Boston, Mass., $1.
(29) *Journal,* Royal Society of Arts, London, England, 6d.
(32) *Mémoires et Compte Rendu des Travaux,* Soc. Ing. Civ. de France, Paris, France.
(33) *Le Génie Civil,* Paris, France, 1 fr.
(36) *Cornell Civil Engineer,* Ithaca, N. Y.
(42) *Proceedings,* Am. Inst. Elec. Engrs., New York City, $1.
(43) *Annales des Ponts et Chaussées,* Paris, France.
(45) *Coal Age,* New York City, 10c.
(46) *Scientific American,* New York City, 15c.
(47) *Mechanical Engineer,* Manchester, England, 3d.
(54) *Transactions,* Am. Soc. C. E., New York City, $12.
(55) *Journal,* Am. Soc. M. E., New York City, $10.
(56) *Transactions,* Am. Inst. Min. Engrs., New York City, $6.
(57) *Colliery Guardian,* London, England, 5d.
(58) *Proceedings,* Engrs.' Soc. W. Pa., 2511 Oliver Bldg., Pittsburgh, Pa., 50c.
(59) *Proceedings,* American Water-Works Assoc., Troy, N. Y.
(60) *Municipal and County Engineering,* Indianapolis, Ind., 25c.
(61) *Proceedings,* Western Railway Club, 225 Dearborn St., Chicago, Ill., 25c.
(62) *American Drop Forger,* Thaw Bldg., Pittsburgh, Pa., 10c.
(63) *Minutes of Proceedings,* Inst. C. E., London, England.
(64) *Power,* New York City, 5c.
(65) *Official Proceedings,* New York Railroad Club, Brooklyn, N. Y., 15c.
(66) *Gas Journal,* London, England, 6d.
(67) *Cement and Engineering News,* Chicago, Ill., 25c.
(71) *Journal,* Iron and Steel Inst., London, England.
(71*a*) *Carnegie Scholarship Memoirs,* Iron and Steel Inst., London, England.
(72) *American Machinist,* New York City, 15c.
(73) *Electrician,* London, England, 18c.
(74) *Transactions,* Inst. of Min. and Metal., London, England.
(75) *Proceedings,* Inst. of Mech. Engrs. London, England.
(77) *Journal,* Inst. Elec. Engrs., London, England, 5s.
(83) *Gas Age,* New York City, 15c.
(85) *Proceedings,* Am. Ry. Eng. Assoc., Chicago, Ill.
(86) *Engineering and Contracting,* Chicago, Ill., 10c.

(87) *Railway Maintenance Engineer,* Chicago, Ill., 10c.
(89) *Proceedings,* Am. Soc. for Testing Materials, Philadelphia, Pa., $5.
(90) *Transactions,* Inst. of Naval Archts., London, England.
(91) *Transactions,* Soc. of Naval Archts. and Marine Engrs., New York City.
(92) *Bulletin,* Soc. d'Encouragement pour l'Industrie Nationale, Paris, France.
(93) *Revue de Métallurgie,* Paris, France, 4 fr. 50.
(96) *Canadian Engineer,* Toronto, Ont., Canada, 10c.
(98) *Journal,* Engrs. Soc. Pa., Harrisburg, Pa., 30c.
(99) *Proceedings,* Am. Soc. of Municipal Improvements, New York City, $2.
(100) *Professional Memoirs,* Corps of Engrs., U. S. A., Washington, D. C., 50c.
(101) *Metal Worker,* New York City, 10c.
(103) *Mining and Scientific Press,* San Francisco, Cal., 10c.
(104) *The Surveyor and Municipal and County Engineer,* London, England, 6d.
(105) *Chemical and Metallurgical Engineering,* New York City, 25c.
(106) *Transactions,* Inst. of Min. Engrs., London, England, 6s.
(107) *Schweizerische Bauzeitung,* Zürich, Switzerland.
(109) *Journal,* Boston Soc. C. E., Boston, Mass., 50c.
(110) *Journal,* Am. Concrete Inst., Philadelphia, Pa., 50c.
(111) *Journal of Electricity, Power and Gas,* San Francisco, Cal., 25c.
(113) *Proceedings,* Am. Wood Preservers' Assoc., Baltimore, Md.
(114) *Journal,* Institution of Municipal and County Engineers, London, England, 1s. 6d.
(115) *Journal,* Engrs.' Club of St. Louis, St. Louis, Mo., 35c.
(116) *Blast Furnace and Steel Plant,* Pittsburgh, Pa., 15c.
(117) *Engineering and Cement World,* Chicago, Ill.
(118) *Times Engineering Supplement,* London, England, 2d.
(119) *Landscape Architecture,* Harrisburg, Pa., 50c.
(120) *Automotive Industries,* New York City, 15c.

LIST OF ARTICLES

Bridges.

Notes on the Construction of the Mystic River Bridge, Everett Extension of the Boston Elevated Railway Company.* Clarence T. Fernald. (109) Oct.
Mystic River Bridge, Description of Superstructure.* John C. Moses. (109) Oct.
The Electrical Equipment of Keadby Bridge.* (26) Oct. 18.
Method of Strengthening the Tongabuddra Bridge of Madras Railway.* (From *Indian Engineer.*) (86) Oct. 30.
Direct Design of Curvature of Arches.* Frank Barber. (96) Oct. 31.
Investigating Old Bridges for Heavier Loading. C. F. Loweth. (Paper read before Am. Ry. Bridge and Bldg. Assoc.) (87) Nov.; (13) Nov. 7.
Mechanical Features of the Vertical-Lift Bridge.* Horatio P. Van Cleve. (55) Nov.
The Principal Bridges of the World. (19) Serial beginning Nov. 2.
Bridge Construction with Timber, Concrete and Stone Under Present Conditions. O. L. Grover. (96) Nov. 21.
New Impact Formulas Needed in Designing Bridges of Various Types. J. A. L. Waddell. (13) Nov. 21.
Reinforced Concrete Trestles.* (19) Nov. 23.
Reinforced Concrete Slab Bridge Design Based on Tests of Full-Size Slabs.* A. T. Goldbeck. (Abstract of article in *Public Roads.*) (86) Nov. 27.
Special Foundation Work for a Railroad Bridge.* J. H. Merriam. (15) Nov. 29.

Electrical.

Temperature Indicator for Transformer Winding.* V. M. Montsinger and A. T. Childs. (Abstract of article in *General Electric Review.*) (73) Sept. 27.
Experimental Examination of the Arc in Gases Under Pressure.* W. Mathiesen. (Abstract of article in *Elektrotechnische Zeitschrift.*) (73) Sept. 27.
The Technics of Magneto-Magnets.* Ellis H. Crapper. (11) Oct. 4.
New Commonwealth Edison Turbine.* J. F. Johnson. (Abstract of article in *Electric Journal.*) (73) Serial beginning Oct. 4.
The Snook Apparatus for the Generation of High-Tension Uni-Directional Currents.* Russell S. Wright. (73) Oct. 4.
The Size and Working Cost of Machines for Continuous-Current Transformation. Thomas Carter. (73) Oct. 11.
110 000-Volt Transmission Line Over the St. Lawrence River.* S. Svenningson. (42) Nov.
The Measurement of Transmission-Factor.* M. Luckiesh and L. L. Mellor. (3) Nov.
The Power Station at Millers Ford.* (117) Nov. 1.
Operation of Direct-Current Motors in Parallel or Series.* Gordon Fox. (64) Nov. 5.

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* Illustrated.

Electrical—(Continued).

The Owen Automatic Lighting and Power Unit.* P. M. Heldt. (120) Nov. 7.
Caring for D. C. Aluminum Car Arresters During the Winter. R. T. Wagner. (17) Nov. 16.
Economical Increase Made in Distribution Capacity.* S. Bingham Hood. (27) Nov. 30.

Marine.

Stresses in Ships.* Sydney V. James. (4) May.
Discussion of Certain Problems in Regard to Marine Diesel Oil Engines. John W. Anderson. (55) Nov.
New Lake Shipyard has Side-Launching Ways Under Cover.* (13) Nov. 7.
Large Freighters of Isherwood Framing Adapted to Bridge-Shop Fabrication. (13) Nov. 7.
Many Tests Made in Study of Concrete Ships.* (13) Nov. 14.
Some Heavy Fitting-Out Cranes—1, Fixed Cranes at Kearny and Hog Island Yards. (13) Nov. 14.
Concrete Ship Design.* R. J. Wig. (From Report to Shipping Board.) (117) Nov. 15.
Different Types of Framing in Two New Government Reinforced-Concrete Ships.* (13) Nov. 28.

Mechanical.

The Design of Governors, with Special Reference to Small Diesel Engines.* Arthur B. Lakey. (58) July.
The Pfalz Single-Seater Biplane.* (12) Sept. 27.
Steam Turbines for Natural Steam Power Plant at Larderello, Italy.* (11) Sept. 27.
The Reactions of Carbonization. (118) Oct.
Coke Handling at Manchester Corporation Gas Works.* George Frederick Zimmer. (11) Oct. 4.
Blue Water Gas Practice, in Conjunction with Benzol Recovery.* E. F. Keable. (Paper read before Eastern Counties Gas Assoc.) (66) Oct. 8.
A. E. G. Armoured Aeroplane. (11) Oct. 11.
An Analysis of "Gas Unaccounted For". Stephen Lacey. (66) Oct. 15.
Control of Fuel and Air in Burning Powdered Coal. W. G. Wilcox. (Abstract of paper read before Am. Chemical Soc.) (57) Oct. 18.
Operation of Steam Turbines.* J. Humphrey. (22) Oct. 18.
Gas Economies, with Special Regard to Carbonization and the Treatment and Disposal of Residual Products. James Dickson. (Paper read before Scottish Junior Gas Assoc.) (66) Oct. 22.
Moisture and Spontaneous Heating of Stored Coal.* S. H. Katz and H. C. Porter. (From U. S. Bureau of Mines, *Technical Paper 172*). (57) Oct. 25.
Silica and Other Refractory Bricks Made from Non-Plastic Materials. G. W. Mottram. (Paper read before Ceramic Soc.) (22) Oct. 25; (57) Oct. 18.
The Corrosive Action of Flue Dust on Firebricks.* J. W. Mellor and W. Emory. (Abstract of paper read before Ceramic Soc.) (22) Oct. 25.
Pulverized Fuel in a Milwaukee Power Plant.* John Anderson. (18) Oct. 26.
Automatic Engine Stops. Walter Greenwood. (Abstract of paper read before Assoc. of Iron and Steel Elec. Engrs.) (64) Oct. 29.
The 300-H. P. Maybach Aircraft Engine.* (120) Oct. 31.
Electric Motors in the Cement Industry. R. B. Williamson. (42) Nov.
The Measurement of Thread Gages.* H. L. Van Keuren. (55) Nov.
The Conservation of Heat Losses from Pipes and Boilers.* Glen D. Bagley. (55) Nov.
Industrial Power Problems. W. F. Uhl. (55) Nov.
Properties of Airplane Fabrics.* E. Dean Walen. (55) Nov.
Valves and Fittings for High Hydraulic Pressures.* Wm. W. Gaylord. (55) Nov.
Value of Heat Insulation in Furnaces. A. W. Knight. (62) Nov.
Uniform and Constant Forced-Feed Lubrication of the Steamchests, Cylinders and Other Parts of Steam Engines.* (21) Nov.
Fuel Oil and Its Applications. A. F. Baillie. (From paper read before Manchester Assoc. of Engrs.) (57) Nov. 1.
Shock in Hydraulic Systems. Alfred Towler. (From paper read before Leeds Assoc. of Engrs.) (57) Nov. 1.
Unusual Carbonizing Methods. James A. Brown. (83) Nov. 1.
Development of Steam-Boiler Baffles.* Albert A. Straub. (64) Nov. 5.
A Short Talk on Boiler Efficiency. Charles H. Bromley. (64) Nov. 5.
Waste Due to Excessive Non-Combustible in Coal. W. A. Shoudy. (64) Nov. 5.
The Sopwith "Camel".* (120) Nov. 7.
Research and Progress in By-Product Coking in Great Britain. J. B. C. Kershaw. (45) Serial beginning Nov. 7.

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* Illustrated.

Mechanical—(Continued).

Diffusion of Oxygen Through Stored Coal.* J. H. Katz. (From U. S. Bureau of Mines, *Technical Paper 170.*) (57) Nov. 8.

Study of Silica Products. A. Bigot. (Abstract of paper read before the Ceramic Soc.) (22) Nov. 8; (57) Oct. 25.

Maintenance of a Proper Heat Balance.* R. N. Ehrhart. (64) Nov. 12.

Condensers and Condenser Engineering Practice. D. D. Pendleton. (Abstract of paper read before Assoc. of Iron and Steel Elec. Engrs.) (64) Nov. 12.

Some Heavy Fitting-Out Cranes—1, Fixed Cranes at Kearny and Hog Island Yards. (13) Nov. 14.

Lignitic Coal, Its Characteristics and Utilization.* (83) Nov. 15.

Pulverizing Coal. J. Cunliffe. (Abstract of paper read before Vancouver Chamber of Mines.) (117) Nov. 15.

Place 8-In. Main Across 1 300-Ft. Estuary in Single Day.* W. M. Henderson. (24) Nov. 16.

Mechanical Cavalry: The Tanks That Have Revolutionized Methods of Assault.* (19) Nov. 16.

The Zeppelin Biplane.* Jean Lagorgette. (Abstract of paper in *The Aeroplane.*) (19) Nov. 16.

How the 155-Mm. Howitzer is Made.* J. V. Hunter. (72) Serial beginning Nov. 21.

Fans and Boilers. W. D. Owens. (45) Nov. 21.

Lubrication and Fuel Tests. P. J. Dasey. (Paper read before Soc. of Automotive Engrs.) (120) Nov. 21.

Explosive, Expansive and Perforating Bullets.* Claude Pernelle. (Translated from *La Nature.*) (19) Nov. 23.

Resistance of Hot Spark Plug Insulators.* R. H. Cunningham. (120) Nov. 28.

Labor-Saving Methods and Appliances for Loading Coal.* G. W. Engel. (45) Nov. 28.

A New British Coke-Fired Steam Commercial Vehicle.* (120) Nov. 28.

The Manufacture of Semi-Steel Shells.* (20) Nov. 28.

Burning Powdered Coal Successfully. (17) Nov. 30.

Metallurgical.

Annealing Cold-Rolled Aluminium Sheet by Abbreviated Exposures at Various Temperatures.* Robert J. Anderson. (Paper read before Inst. of Metals.) (11) Oct. 4.

Rapid Recrystallization in Deformed Non-Ferrous Metals.* D. Hanson. (Paper read before Inst. of Metals.) (11) Oct. 11.

Electric Rolling Mill Plant.* (12) Oct. 11.

Zirconia: Its Occurrence and Application. H. C. Meyer. (Abstract of paper read before Ceramic Soc.) (22) Oct. 25.

Determination of Chromic Oxide in Chromite. W. C. Riddell and Esther Kittredge. (103) Oct. 26.

Equipment Data on Heat Treat Furnaces.* (62) Nov.

Inspecting Metallic Electrode Arc Welds.* O. S. Escholz. (62) Nov.

The Ferro-Alloys. J. W. Richards. (Paper read at National Exposition of Chemical Industries.) (16) Nov. 2.

Recovery of Potash from Blast Furnaces. Linn Bradley. (From paper read before National Exposition of Chemical Industries.) (20) Nov. 7.

Improving Foundry Sand Mixtures.* Henry B. Hanley. (Abstract of paper read before Am. Foundrymen's Assoc.) (20) Nov. 7.

Making Sand-Cast Forging Ingots.* W. L. Booth. (Article from *Metal Trades.*) (20) Nov. 7.

Smelting Cyanide Silver-Precipitate in Oil-Burning Reverberatory Furnaces.* K. A. Cunningham and Arthur Feust. (103) Nov. 9.

A Modern Pouring System.* Mark P. Ohlsen. (Abstract of paper read before Am. Foundrymen's Assoc.) (20) Nov. 14.

The Integrity of the Malleable Casting. Enrique Touceda. (From paper read before Am. Foundrymen's Convention.) (20) Nov. 14.

Electric Furnace in the Steel Foundry. W. E. Moore. (From paper read before Am. Foundrymen's Convention.) (20) Nov. 14.

Metallurgical Practice on Cinnabar at Istria, Austria.* Roland Sterner-Rainer. (Translated from *Osterreichische Zeitschrift fur Berg- und Huttenwesen.*) (105) Nov. 15.

Die-Casting of Aluminium-Bronze. H. Rix and H. Whitaker. (Paper read before Inst. of Metals.) (19) Nov. 16.

Modern Coreroom for Malleable Foundry.* Donald S. Barrows. (20) Nov. 21.

Differential Flotation of Lead and Zinc Sulphides.* Algernon Del Mar. (103) Nov. 23.

A Dry-Concentration Plant in Arkansas.* Tom Shiras. (16) Nov. 23.

Sorting Ore for Metallurgical Treatment.* A. W. Allen. (16) Nov. 30.

The Determination of Tin in High-Grade Wolfram Ores.* A. R. Powell. (From *Transactions*, Soc. Chem. Ind.) (16) Nov. 30.

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* Illustrated.

Military.

An Ambulance Train for the American Army.* (12) Sept. 27.
Military Explosives of To-day.* J. Young. (29) Serial beginning Oct. 4.
The Elliptic Trajectory Over the Earth.* G. Greenhill. (11) Oct. 11.
A. E. G. Armoured Aeroplane.* (11) Oct. 11.
The 300-Hp. Maybach Aircraft Engine.* (120) Oct. 31.
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Mechanical Cavalry: The Tanks That Have Revolutionized Methods of Assault.* (19) Nov. 16.
The Zeppelin Biplane.* Jean Lagorgette. (Abstract of paper in *The Aeroplane.*) (19) Nov. 16.
How the 155-Mm. Howitzer is Made.* J. V. Hunter. (72) Serial beginning Nov. 21.
Explosive, Expansive and Perforating Bullets.* Claude Pernelle. (Translated from *La Nature.*) (19) Nov. 23.
The Manufacture of Semi-Steel Shells.* (20) Nov. 28.

Mining.

The Unwatering of the Pensford Colliery.* Charles Lewis. (Paper read before Assoc. of Min. Elec. Engrs.) (22) Oct. 4.
Primary Considerations in Hydraulic Stowing.* C. A. John Hendry. (Abstract of paper read before Geol. and Min. Soc. of India.) (57) Oct. 18.
Repairing Induction Motors.* (Mining) L. Fokes. (57) Oct. 25.
Peabody Coal Development in Central Illinois.* George W. Harris. (45) Oct. 31.
Concrete Mine Workings.* S. O. Andros. (117) Nov. 1.
The Science of Quarrying Rock with Explosives.* J. H. Squires. (117) Nov. 1.
The Preparation of a New Plan for a Colliery.* George A. Gilchrist. (Paper read before National Assoc. of Colliery Managers.) (22) Nov. 1.
Removal of a Vertical Shaft Pillar.* J. Chilton. (From *Journal* of the Chemical, Metal. and Min. Soc. of South Africa.) (57) Nov. 1.
Dust Abatement in Mines.* W. O. Borcherdt. (From paper read before National Safety Council.) (16) Nov. 2.
Modern Substations of Large Anthracite Distribution System.* (45) Nov. 7.
Cooling and Drying the Air in Deep Mines. Sydney F. Walker. (22) Nov. 8.
Progress of Electricity in Coal Mining.* Frank Huskinson. (45) Nov. 14.
Calculating Traverses without Tables.* A. J. Sale. (103) Nov. 16.
Capacity of Belt Magnetic Separators.* George J. Young. (16) Nov. 16.
Sampling and Analysis of Chromite. Abbot A. Hanks. (103) Nov. 16.
Re-opening the Golden Eagle Shaft.* F. Bean Bradley. (16) Nov. 16.
Operating Cost of Electric Shovels in Underground Mining.* (86) Nov. 20.
Surface Plant of the Orient Mine in Franklin County, Illinois.* (45) Nov. 21.
Well-Drill Blasting.* J. C. Costello. (103) Nov. 23.
Controlling the Drawing-Off in Caving Stopes.* A. B. (16) Nov. 23.
Occlusion of Explosive Gases in Coal. James Ashworth. (45) Nov. 28.
Las Vacas Gold Mine, Chile.* E. David Pope. (16) Nov. 30.

Miscellaneous.

Military Explosives of To-Day.* J. Young. (29) Serial beginning Oct. 4.
Recent Developments in Leather Chemistry. Henry R. Procter. (29) Serial beginning Oct. 25.
Costing at National Factories.* W. Webster Jenkinson. (Abstract of paper read before London School of Economics and Political Science.) (22) Serial beginning Oct. 25.
The Human Factor in Task Setting. W. E. Camp. (9) Nov.
Employment Department Routine of the Curtiss Aeroplane & Motor Corp. Charles E. Fouhy. (9) Nov.
Nitrogen Fixation Furnaces.* E. Kilburn Scott. (Paper read before Electrochemical Soc.) (105) Serial beginning Nov. 15.
Nitric Acid as a By-Product of Internal Combustion Engines.* A. W. H. Griepe. (24) Nov. 23.
The Valuation Aspect of Abandoned Property. Wm. G. Raymond. (15) Nov. 29.

Municipal.

The City of Birmingham Arterial Roads Improvement.* Henry E. Stilgoe. (114) July.
Public Works in Stretford.* Ernest Worrall. (114) Oct.
Town Planning in Relation to Public Safety. Thomas Adams. (Abstract of article from *Conservation of Life.*) (96) Oct. 31.
The Problem of City Development: An Economic Survey.* A. G. Dalzell. (5) Nov.
Construction Plans Developed for the Bronx River Parkway Reservation.* L. G. Holleran. (13) Nov. 14.

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* Illustrated.

Roads and Pavements.

Maintenance of Roads in Rural Areas. James A. Webb. (114) Aug.
Further Notes on Road Construction. George Green. (114) Aug.
Some Random Notes on Roads, Traffic and Improvements. A. Dryland. (114) Aug.
Recommended Procedure in the Use of Explosives on Road Construction.* (60) Nov.
Standardization of Pavement Design and Construction.* Prévost Hubbard. (60) Nov.
The Maintenance of Asphalt Pavements by the Cut and Replace Method.* James W. Routh. (60) Nov.
The Measure of a Good Road. Robert C. Barnett. (86) Nov. 6.
Gasoline Consumption Tests Demonstrate Value of Hard, Smooth-Surface Roads.* A. N. Johnson. (13) Nov. 7.
Oiled Macadam Roads Resurfaced with Concrete.* E. A. Burt. (13) Nov. 21.
Capacity of Macadam Roads for War Business Increased.* (13) Nov. 23.
Road Maintenance Methods and Devices Effect Saving of Material, Labor and Fuel.* (13) Nov. 28.

Railroads.

The Pneumatic Method of Concreting.* H. B. Kirkland. (4) May.
An Ambulance Train for the American Army.* (12) Sept. 27.
4-6-0 Passenger Engine and Double Bogie Tender, London and South-Western Railway.* (21) Oct.
Electric Railways in Argentina: C. A. R. Suburban Lines. (118) Oct.
Electric Traction on the Central Argentine Railway.* (12) Serial beginning Oct. 18; (11) Serial beginning Oct. 18; (73) Oct. 18; (26) Oct. 18.
Resilient Chairs and Reinforced Concrete Ties for Railway Track.* (From *Indian Engineer.*) (86) Oct. 30.
Standard Six-Wheel Switcher.* (25) Nov.
Virginian 2-10-10-2 Locomotives.* (25) Nov.
Data for Standard Locomotives.* (25) Nov.
Car Department of the Milwaukee. (25) Nov.
Heavy Switch Plate Construction.* (87) Nov.
Industrial Tractors for Solving Freight Terminal Congestion.* (117) Nov. 1.
Terminal Shop and Classification Yard Lighting.* (18) Nov. 2.
Freight Tunnel Transportation in Chicago. Nelson W. Pierce. (18) Nov. 2.
American-Built Railroad Cutoff Will Relieve Traffic Congestion in France.* Robert K. Tomlin. (13) Nov. 7.
Railway Water Supply from Wells. (From Report to Am. Ry. Bridge and Building Assoc.) (18) Nov. 9; (87) Nov.
"Fighting" Snow.* J. M. Pneuman. (17) Nov. 9.
New York Central Relocates Lines to Cross Barge Canal at the Tonawandas.* B. S. Voorhees. (13) Nov. 14.
Mountain Type Locomotive for the Santa Fé.* (18) Nov. 16.
Coal-Handling Plant of Virginian Railway.* E. F. Case. (18) Nov. 23.
New Equipment in the Harvard Avenue Yard, Cleveland Railway.* (17) Nov. 30.

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* Illustrated.

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JOHNSON, FRANCIS WHITTIER. — Transferred to Grade of Associate Member, 989.

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KEMPKEY, AUGUSTUS. — Transferred to Grade of Member, 1104.

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Killion, Louis John.—Elected an Associate Member, 786.

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King, Wesley Eugene.—Transferred to Grade of Member, 598.

Kirby, Luther Hill.—Elected an Associate Member, 597.

Kircher, Paul.—Elected an Associate Member, 988.

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Koch, Edward Louis.—Elected an Associate Member, 1102.

Koester, Edwin Ferdinand.—Elected a Junior, 989.

Kone, Samuel Louis.—Elected an Associate Member, 455.

Kraus, Arthur. — Transferred to Grade of Associate Member, 787.

Kruse, Otto Von.—Elected an Associate Member, 597.

Kwan, Tsu Chang.—Elected a Junior, 989.

Lacher, Walter Scott.—Elected an Associate Member, 597.

Lamont, Clarence Booth.—Death announced, 456.

Lane, Albert Lossen.—Elected a Junior, 455.

Langthorn, Jacob Stinman.—Nominated as Director, 891.

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Larkin, Charles Raymond.—Elected a Junior, 108.

Larsen, Peter Magnus.—Elected an Associate Member, 107.

Larson, Reuben Lawrence.—Elected an Associate Member, 597.

Larue, Luther.—Elected an Associate Member, 600.

Lashmet, Luther Clyne.—Elected an Associate Member, 455.

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Learned, Albert Preisach.—Transferred to Grade of Associate Member, 598.

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Logan, James Bailey.—Elected an Associate Member, 988.

Logan, William Stevenson, Jr.—Elected an Associate Member, 1102.

Long, Verne Vere.—Elected an Associate Member, 597.

Loveland, Charles Dubuisson. — Elected an Associate Member, 597.

Lowden, Spencer William.—Elected an Associate Member, 988.

Lowe, Jesse.—Death announced, 456.

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Lundgren, Leonard.—Transferred to Grade of Member, 598.

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Lyon, George Edmund.—Elected a Junior, 989.

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McCoy, Curtis John.—Elected an Associate Member, 600.

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McGee, Arthur Branch. — Elected a Junior, 108.

McGee, Harold Gilbert. — Transferred to Grade of Associate Member, 456.

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McIntyre, Lewis Wedsel.—Elected an Associate Member, 349.

McKean, Harry Parker. — Transferred to Grade of Associate Member, 1104.

McKelvey, James Gray.—Elected a Junior, 455.

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McMillan, William Bruce.—Transferred to Grade of Associate Member, 109.

McMullen, Clements.—Elected a Junior, 597.

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McNeal, Thomas Carl.—Elected a Junior, 349.

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McPike, Martin John.—Elected an Associate Member, 786.

Mahoney, Joseph Nathaniel. — Elected a Member, 988.

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Maloy, Thomas Franklin.—Elected an Associate Member, 600.

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Martin, Lloyd Littell. — Elected a Junior, 989.

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Mathias, Jared Leroy.—Transferred to Grade of Associate Member, 109.

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MILHOLLAND, CLARENCE VICTOR. — Elected an Associate Member, 455.

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MILLER, JOHN OWEN.—Transferred to Grade of Associate Member, 109.

MILNER, WINFRED LEON.—Transferred to Grade of Member, 598.

MILTON, SAMUEL LAWRENCE.—Elected an Associate Member, 597.

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MURRAY, JOHN BONAVENTURE.—Death announced, 785.

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NICHOLS, ROBERT BRADLEY.—Elected an Associate Member, 455.

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O'BRIEN, WILLIAM ARTHUR. — Death announced, 990.

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Okun, Abraham Harry.—Elected a Junior, 600.

Olmsted, Roger Wolcott.—Elected an Associate Member, 600.

Olson, John Nathaniel. — Transferred to Grade of Associate Member, 787.

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Paine, Rennick Rubenell.—Elected an Associate Member, 107.

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Palmer, Herbert Martin.—Elected a Junior, 455.

Palmer, Richard Jeter, Jr.—Death announced, 991.

Palmer, Wallace Cromwell Allen. —Transferred to Grade of Member, 788.

Parke, Samuel Reynolds.—Elected an Associate Member, 349.

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Pendleton, Thomas Percy.—Elected an Associate Member, 1102.

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Picken, Marshall Woolley. — Elected a Junior, 787.

Pierce, Chauncey Arthur.—Elected an Associate Member, 786.

Pinney, James Charles, Jr.—Elected a Member, 454.

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Poole, Ruble Isaac.—Transferred to Grade of Associate Member, 109.

Porterfield, Roy Albert.—Elected an Associate Member, 597.

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Potts, Wilmer Houston.—Elected an Associate Member, 600.

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Preston, John Owings.—Elected a Junior, 108.

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Redman, Dwight Raymond.—Elected an Associate Member, 600.

Reed, Charles Alley.—Elected an Associate Member, 786.

Reichardt, Walter Frederick. — Transferred to Grade of Member, 108.

Reidpath, Elbert Hume. — Transferred to Grade of Associate Member, 598.

Reimann, Robert.—Transferred to Grade of Member, 456.

Reinke, Edward Alexander. — Elected a Junior, 455.

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PAPERS AND DISCUSSIONS

DECEMBER, 1918

Vol. XLIV. DECEMBER, 1918. No. 10.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852.

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications.

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AMERICAN SOCIETY OF CIVIL ENGINEERS
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DETERMINATION OF THE DUTY OF WATER BY ANALYTICAL EXPERIMENT

Discussion.*

By S. T. Harding, Assoc. M. Am. Soc. C. E.

Mr. Harding.

S. T. Harding,† Assoc. M. Am. Soc. C. E. (by letter).‡—Mr. Hammatt has presented the results of considerable detailed work on some of the factors affecting the use of water for meadow lands. The irrigation of native grass meadows and pastures by methods involving more or less continuous application of water is found in many localities throughout the West where climatic conditions make the production of crops of higher value uncertain. The nature of the field methods used makes it difficult to segregate the use of water on small areas for experimental purposes without introducing artificial conditions, and it is noticeable that State and Federal agencies have done very little experimental work on such crops.

To meet these conditions, Mr. Hammatt adopts a method which gives him control of some of the elements observed. In any experimental work involving the duty of water, two conditions must be secured in order to get results which can be applied to field conditions. The first of these is to be certain that the conditions of the experiment are similar to those in the fields; the second is that all essential elements are subject to control and measurement. The use of small volumes of soil in tanks satisfies the second of these considerations, but it may be open to question in regard to the first, although Mr. Hammatt has reduced the differences from field conditions to a minimum.

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* Discussion of the paper by W. C. Hammatt, M. Am. Soc. C. E., continued from October, 1918, *Proceedings*.

† Berkeley, Cal.

‡ Received by the Secretary, November 21st, 1918.

Mr. Harding. In many respects the practice described by the author resembles that used in rice irrigation in California. The water is held on the land during a large part of the growing season and is subject to similarly varying evaporation and transpiration losses during the different stages of growth of the rice. Owing to the method of preparing rice lands in checks, the waste or run-off is much less than that estimated by the author for sugar grass. As far as the writer can ascertain, no results of similar observations on rice under field conditions have been published, although the lack of percolation on many rice lands offers an opportunity for observation of evaporation and transpiration during the different stages of growth.

The duty of water depends, not only on the quantity required by plants for their growth, but also on the quantity which it is necessary to use under reasonable standards of practice in order that that required for direct use can be made available to the plants at the time needed. This latter requirement may result in the use of quantities considerably in excess of the direct crop requirements where the conditions are such as to cause large surface waste or deep percolation losses. The only way in which the efficiency of application can be determined is under field conditions. It is noticeable that the detailed work by the author only covered 60% of the total recommended use, an estimated allowance of 40% being included for surface waste.

Mr. Hammatt adds 33% to his estimated evaporation from a deep tank in order to ascertain the evaporation from a thin sheet of water such as occurs on the marshes. The results secured by R. B. Sleight, Jun. Am. Soc. C. E., at Denver, Colo.,* indicated an evaporation 11% greater in June from a tank 3 in. deep than from one 5.75 ft. deep, and of 12% less in October. Mr. Sleight's tanks were more comparable than those used by Mr. Lee, on which Mr. Hammatt's estimate was based. Mr. Sleight found that the placing of a shallow tank above ground gave a higher evaporation, by more than 20%, than a similar tank set in the ground. Mr. Lee's shallow tank was set largely above the ground.

The author's statement, that "the ratio of the quantity of water transpired to the quantity of plant matter produced * * * is within such close limits as to be to a certain extent measurable", and the results given relative to transpiration for various standard crops, are, in the writer's opinion, more likely to be misleading than helpful, if an attempt is made to apply them in general irrigation practice. When yields may be varied 100% by various fertilizer treatments for soils receiving equivalent moisture, as under humid conditions, it is evident that the "transpiration ratio", so called, gives little guidance as to the proper duty of water.

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* *Journal of Agricultural Research,* July 30th, 1917.

Mr. Harding.

Mr. Hammatt states that his previous observations had corroborated Mr. Lee's conclusion that, with ground-water at a depth of about 8 ft., soil evaporation would be negligible, and, for any depth to ground-water of less than 8 ft., the quantity of evaporation would be proportional to the depth.

It is the writer's opinion that the results presented by Mr. Lee* do not warrant this as a general conclusion, and that the results of other published experiments show that the depth from which water will be drawn to the surface depends very materially on the texture of the soil. Unfortunately, descriptions of the soil, as given in the reports of some of such work, are too indefinite to permit of making full use of the results.

EFFECT OF SOIL TEXTURES ON EVAPORATION FROM SOILS

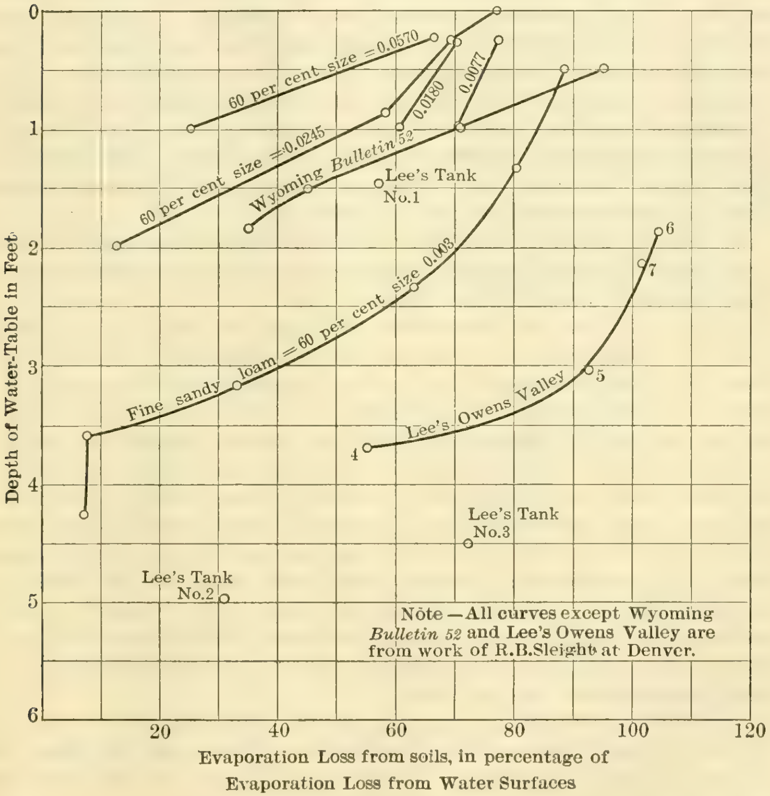

FIG. 24.

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* *Transactions*, Am. Soc. C. E., Vol. LXXVIII, p. 148.

Mr. Harding. In order to compare observations of soil evaporation made in different localities, some means of correlating climatic factors is required. The evaporation from a water surface is probably the best single unit for this purpose. In Fig. 24 a number of such observations have been assembled, the evaporation from the soil being expressed as a percentage of that from a water surface at the same locality.

Five of the results given are from Mr. Sleight's work at Denver, reference to which has been given. Mr. Sleight defines the texture of the material by the size of the opening of a screen, in inches, such that 60% of the material passes and 40% is retained. The tanks used were 2 ft. in diameter, and the results have been compared with the evaporation from a water surface in a tank of similar size. The coefficients which should be used in reducing the evaporation from soils in tanks to that from large areas are not known; some limited experiments by Mr. Sleight indicate a more marked variation from soils than from water. The four coarser materials are river-bed sands; the fine sandy loam is from the soil at the laboratory.

The results given in *Bulletin 52* of the Wyoming Experiment Station were secured in 6-in. tanks containing soil cores taken in the field. The texture of the soil is not given.

In his work, Mr. Lee states that No. 2 tank was filled by replacing the soil as found with the stratification as existing in the adjacent soil. Tank No. 3 had a layer of black loam soil under the sod, the remainder of the soil being mixed. It is stated that Tanks Nos. 4 to 7 contained a mixture of clay, soil, and fine sand, a rather general description. A curve based on Tanks Nos. 4 to 7 only, omitting Tanks Nos. 2 and 3, which do not plot consistently with the others, would, if extended, indicate a zero evaporation for this mixed soil when the water-table is somewhat more than 4 ft. below the surface. Mr. Lee's soil tanks were 7½ ft. in diameter, his deep-water tank was 3½ ft. in diameter, and would have a coefficient of 0.83, according to Mr. Sleight's experiments. This coefficient was applied to the evaporation from the deep-water tank, as the larger size and growth of sod would probably give a small correction for the soil tanks.

Mr. Lee's Tank No. 1 was without sod, but had on the surface 2½ ft. of clean river sand of mixed sizes. The results for June to September, 1910, are given in *Water Supply Paper No. 294,* and are plotted on Fig. 24.

From the curves on Fig. 24 several conclusions may be drawn. The most evident one may be the need of more thorough investigations of this subject, giving more consideration to the texture and arrangement of the material. It also appears, however, that the depth from which moisture will be drawn to the surface, and the extent of evaporation from different depths, varies very materially with the texture of the soil. For coarser materials, the depth from which evaporation will

Mr. Harding.

occur may be less than 2 ft.; data are lacking on soils of heavy texture. The fine sandy loam at Denver indicates little loss for depths of more than 5 ft. on such medium to light soils.

The results of Mr. Lee's work are the only ones given for a soil supporting vegetation. The increased proportion of loss from his Tanks Nos. 4 to 7 may be due to the heavier texture of the soil or to the additional effect of the salt grass roots in drawing water for transpiration, the description of the soil is too indefinite to enable one to compare it with the other experiments.

The results in general indicate that in coarse material, with the water-table 3 in. below the surface, the evaporation will be less than from an adjacent water surface; with medium or heavy soils it may equal or exceed such loss from a water surface.

The evaporation from soils is often an important item in matters involving the loss from marshes, the salvage in water which may be effected by drainage, the water requirement of such crops as those included in Mr. Hammatt's work, and in the saving that may be secured in cultivation with soil mulches. The field of investigation is one requiring much careful experimental work and analysis of results, the data available are limited, and there is much opportunity for additional work.

MEMOIRS OF DECEASED MEMBERS.

NOTE.—Memoirs will be reproduced in the volumes of *Transactions*. Any information which will amplify the records as here printed, or correct any errors, should be forwarded to the Secretary prior to the final publication.

AUSTIN LORD BOWMAN, M. Am. Soc. C. E.*

DIED JUNE 3D, 1915.

Austin Lord Bowman, Chief Engineer of the Department of Bridges of New York City, and former Director of this Society, died on June 3d, 1915, after a short illness, in the prime of his vigorous and useful manhood.

He was born on November 14th, 1861, at Manchester, N. H., the second son of the Rev. George Augustus and Ernestine Lord Bowman, and was of Puritan and Pilgrim ancestry on both his father's and mother's side of the family.

He prepared for college at the public High School, Hartford, Conn., and entered Yale in 1879. He was graduated with high honors (Phi Beta Kappa) in 1883, with the degree of B. A.

Mr. Bowman's college course was marked with the same painstaking and conscientious work that characterized his professional career later, and by the determination to master whatever lines of work he undertook. Although it was necessary for him, in order to assist his finances, to engage in tutoring and other lines of student self-help, he, nevertheless, found time to participate in athletics, winning honors in boxing and wrestling. His college education was made possible largely by his own efforts, and his work and success should be an inspiration to any young man struggling for an education and an honorable professional life. In these days, when we hear so much about the study of the humanities as a supplement or foundation for an engineering course, it is interesting to note that Mr. Bowman's college education covered a B. A. degree, without the technical training thought so necessary at the present time.

From his work with a country surveyor during his vacations, Mr. Bowman was inclined toward engineering, and on his graduation in 1883, he at once secured a position as Rodman in a locating party for the Hartford and Harlem Railroad, between New Haven, Conn., and New York City. The Railroad Company became financially embarrassed in the late Fall, and Mr. Bowman spent the winter at home. He went to Colorado in 1884. In 1885, he worked for a short time in the office of the City Engineer of St. Paul, Minn., and left this employment to take a position as Transitman in a survey party of the Minnesota and Northwestern Railroad. This work was attended by all the hardships of a hurried railroad survey, through a swampy, heavily wooded, and uninhabited country, and with poor camp outfit. Mr. Bowman always retained a vivid recollection of the closing days of this survey, when the party subsisted on lard and blueberries.

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* Memoir prepared by Albert Carr, J. A. Knighton, and Lewis D. Rights, Members, Am. Soc. C. E.

At the close of this work, he was employed as a Transitman on the location and construction of the Chicago, St. Paul and Kansas City Railroad, and on its completion he came back to the East.

In 1887, after a short engagement on river and harbor work in New Jersey, and another short engagement on the construction of the Kings County Elevated Railroad in Brooklyn, he went to Virginia on the location and construction of the Clinch Valley Division of the Norfolk and Western Railroad. He remained with this railroad until 1890, when his chief became identified with the American Bridge and Iron Company, of Roanoke, Va. Mr. Bowman accompanied his chief as Assistant Engineer and Superintendent of Construction, beginning what, later, became his specialty in his professional life.

From 1890 to 1895, he had charge of the construction of many important bridges and other structures throughout the Southern States, and gained much practical experience which was to prove of great value to him in his later work.

In the fall of 1895 the American Bridge and Iron Company suffered financial trouble, and Mr. Bowman spent the next year in the service of the United States Government. During that period he found time to prepare and submit a competitive design for a bridge over the St. Lawrence River at Quebec, Canada, and secured second place in a world-wide competition.

In 1897, he came to New York City and opened an office as Consulting Engineer, specializing in bridge and structural steel work. He continued in private practice for ten years, and during the greater part of this period, was engaged as Consulting Bridge Engineer for the Central Railroad of New Jersey.

In December, 1907, he was appointed Consulting Engineer to the Department of Bridges of New York City, and in July, 1914, became Chief Engineer of the Department.

During his incumbency as Consulting Engineer, many important matters were submitted to him for investigation and report, notably, the question of the safety and traffic-carrying capacity of the Queensborough Bridge. His report was made the basis of the Department plan for the re-arrangement of the structure to accommodate the traffic of the dual subway system.

Under his direction, the Department carried out very elaborate and important stress-strain measurements, in connection with an investigation of the Williamsburg Bridge, the work being done with the assistance of the Bureau of Standards, S. W. Stratton, Director, at Washington, D. C. On the basis of these investigations, arrangements were made to strengthen the shore span by using an additional bent and re-boring some of the pin-holes, so as to use larger pins. This delicate operation* was worked out to complete success.

Mr. Bowman served as Director of the American Society of Civil Engineers from 1905 to 1907; and, from 1909 until his death, he was Chairman of the Special Committee appointed by the Society to consider and report upon Steel Columns and Struts.

The following resolutions were approved by the Column Committee, at a meeting held at Atlantic City, N. J., on June 23d, 1915:

"*Whereas,* it has pleased Almighty Providence to call from his field of earthly labors

Austin Lord Bowman

and,

"*Whereas,* the Column Committee of the American Society of Civil Engineers was honored by his holding the position of Chairman of the Committee from the time of its appointment, and

"*Whereas,* the members of the Column Committee are desirous of expressing their sorrow on account of his loss,

"*Now be it Resolved:* That we, the members of the Column Committee deeply mourn the loss of a sincere friend, a leader among men, an eminent engineer, and a Christian gentleman.

"*Be it further Resolved:* That we desire to record our appreciation of his work in the engineering profession, but more especially on account of his untiring efforts to lead and guide the Column Committee in the solution of one of the great engineering problems of the present generation.

"THE COLUMN COMMITTEE OF THE
AMERICAN SOCIETY OF CIVIL ENGINEERS.

"Committee:

"JAMES H. EDWARDS
CHARLES F. LOWETH
RUDOLPH P. MILLER
RALPH MODJESKI
FRANK C. OSBORN
GEORGE H. PEGRAM
LEWIS D. RIGHTS
GEORGE F. SWAIN
EMIL SWENSSON
J. R. WORCESTER."

Coming at a time when his ability and experience could be of the greatest service to the world, Mr. Bowman's death was a distinct loss to the Engineering Profession.

He was noted for his sympathy and consideration for younger men. No young man coming to him for advice on professional or other problems went away without feeling that he had received more than money could buy.

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* *Engineering News,* Vol. 71, May 14th, 1914.

At the time of his death, Mr. Bowman was a Member of the American Society of Mechanical Engineers, the American Society for Testing Materials, the American Railway Engineering Association, and the Association of Railway Superintendents of Bridges and Buildings. He was also a member of the Yale Club, the Engineers Club, the New York Railroad Club, a charter member of the Massachusetts Society of Mayflower Descendants, a member of the Sons of the American Revolution, and of the Society of Colonial Wars.

In 1883, he was married to Ida, daughter of Garret I. and Mary Jane Van Horne, of Jersey City, N. J., a sister of John G. Van Horne, M. Am. Soc. C. E. His wife died on May 28th, 1905. He again married, in 1907, his second wife being Eleanor, daughter of Matthew and Jane W. Heagen, of New York City, who, with their daughter, Ernestine Jane, survives him.

Mr. Bowman was elected an Associate Member of the American Society of Civil Engineers on September 7th, 1892, and a Member on December 1st, 1897.

ANDREW BRYSON, M. Am. Soc. C. E.*

Died October 1st, 1918.

Andrew Bryson, the only son of Rear-Admiral Andrew Bryson and Charlotte Arnold Bryson, was born in New York City, on September 2d, 1851.

After completing his school life, Mr. Bryson began his engineering work in December, 1869, as Rodman on the Connecticut Western Railroad under the late William F. Shunk, Chief Engineer. Mr. Bryson remained on this work until its completion, having been, for the latter part of the time, in charge of a residency.

From December, 1871, to September, 1872, he was engaged on the New York and Long Branch Railroad as Leveler in charge of a locating party, and as Division Engineer preparatory to construction, which, however, was not undertaken at that time. In September and October, 1872, he served as Transitman on the location of the Rhinebeck and Connecticut and the Walkill Valley (extension) Railroads.

After severing his connection with this work, Mr. Bryson went abroad and visited England, Scotland, and France, remaining until July, 1873, when he went to Canada as Leveler on the surveys for the Missisquoi and Black River Valley Railroad, under Mr. Shunk, Chief Engineer.

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* Memoir prepared by the Secretary from information on file at the Headquarters of the Society.

In April, 1874, he was appointed Division Engineer on the Delaware, Lakawanna and Western Railroad under the late James Archbald, M. Am. Soc. C. E., Chief Engineer. Mr. Bryson retained this position until September, 1878, when he was made Engineer of the Syracuse and Binghamton Railroad, where he remained until August, 1880. During this time, he was appointed Associate Engineer on a project for a proposed bridge across the Niagara River at Lewiston, N. Y., Mr. Bryson representing the American company interested and the late Joseph Hobson, M. Am. Soc. C. E., the Canadian corporation. He also designed and superintended the construction of the docks and coal trestles of the Delaware, Lakawanna and Western Railroad at the foot of Erie Street, Buffalo, N. Y.

From August, 1880, to October, 1882, he served as Division Engineer of the Delaware, Lakawanna and Western Railroad in New York State, and located and superintended the construction of the Third Division, including much heavy work throughout the Genesee Valley.

In October, 1882, he was appointed Chief Engineer of the Hartford and Harlem Railroad and the East River and Connecticut Railroad, which were to form a proposed new line between New York City and New Britain, Conn. After the completion of this work in 1885, Mr. Bryson was employed as Principal Assistant Engineer on the Kings County Elevated Railway, Brooklyn, N. Y., until 1887, when he opened an office in New York City and engaged in the private practice of engineering.

In 1900, Mr. Bryson went to Reading, Pa., where he was engaged in the steel industry as President and Treasurer of the Brylgon Steel Casting Company. In 1905, in order to develop his business and to have the advantage of sea transportation facilities, Mr. Bryson moved his plant to New Castle, Del. He continued as its President until 1916, when the plant was sold to the Penn-Seaboard Steel Casting Company.

From that time until his sudden death from Spanish influenza, on October 1st, 1918, Mr. Bryson had devoted himself to community interests. He was intensely patriotic, and had been a leading spirit in the Liberty Loan and Red Cross drives in New Castle, having served as Chairman of the Men's Committee during the Second and Third Liberty Loan drives and had been engaged on plans and arrangements for the Fourth Loan when he was taken ill.

Cultured, educated, and a man of clear and sound judgment, Mr. Bryson's opinions in matters pertaining to his profession and community interests were often sought by others and were always found to be exceedingly helpful and valuable. He was thoroughly democratic in his dealings with his fellow men, demanding from them only his own standards of honesty, uprightness, and patriotism.

Mr. Bryson was a member of the St. Nicholas Club of New York City, the Loyal Legion, and President of the New Castle Branch of the Navy League. He was also a member of the Board of Trustees of the Presbyterian Church at New Castle. In connection with municipal and Federal affairs, he was a member of the New Castle Board of Trade, a commission appointed for the bonding of New Castle for street paving, the Delaware District Board for the consideration of claims and appeals in the matter of exemptions from military service, and of the Board appointed by the Government to collect information concerning the war facilities of manufacturing interests in his district.

Mr. Bryson was elected a Member of the American Society of Civil Engineers on April 1st, 1885.

HOWARD LINCOLN COBURN, M. Am. Soc. C. E.*

Died June 18th, 1918.

Howard Lincoln Coburn was born on January 13th, 1867, at Patten, Me., the son of America Thayer Coburn, a merchant of that town, and Annabelle (Tine) Coburn, of Lee, Me. He attended the schools of Patten and entered the Massachusetts Institute of Technology in 1883 as a member of the Class of '87.

When he had completed two years of his course in Mechanical Engineering his father met with reverses in business and Mr. Coburn promptly withdrew from college and went to work. He entered the office of Mr. Charles Carr, a mill engineer, of Boston, Mass., with whom he spent most of his time during the ensuing ten years, designing buildings and equipment for New England cotton mills.

After ten years in business, Mr. Coburn re-entered the Massachusetts Institute of Technology in 1896, and was graduated in 1898 with the degree of M. E.

Again taking up mill construction, he spent two years in the office of the late E. D. Leavitt, M. Am. Soc. C. E., of Boston, and then became connected with the firm of Lockwood, Greene and Company, with whom he spent ten years, and rose to be Chief Engineer.

In 1905 he began the work which has made his name most familiar to the Engineering Profession, and to it he continued to devote his talents up to the time of his death. He joined the newly organized Ambursen Hydraulic Construction Company, as Chief Engineer. In the following years, he was responsible for the construction of more than one hundred reinforced concrete dams and hydro-electric developments. His work covered nearly every State in the Union, and included many installations in Canada and the West Indies. Some of his biggest and best known works are the Guayabal Dam, for the Porto

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* Memoir prepared by Spencer W. Stewart, Assoc. M. Am. Soc. C. E.

Rico Irrigation Service, the Bassano Development, for the Canadian Pacific Railway, in Alberta, Canada, the Ozark Dam on the White River, in Missouri, and the La Prele and Shoshone Dams, in Wyoming.

Mr. Coburn made studies of nearly every important river in the United States. At different times he acted as Consulting Engineer to H. L. Doherty and Company, H. M. Byllesby and Company, and other prominent banking houses.

He was a man of unusually attractive personality and had a host of friends, all of whom knew him and loved him as "Pa" Coburn. He was a man to whom other men—especially young men—instinctively went for advice and help, and they always got what they needed. His habit was to be perfectly frank at all times on every subject, but his sympathy and generosity were never failing.

In all his relations, professional and personal, Mr. Coburn's predominant characteristic was absolute sincerity. There was not a square inch of veneer on him, and there was never a doubt of where he stood on any subject. His professional opinions were bluntly stated, and were not subject to review for any consideration, commercial or otherwise.

Mr. Coburn never married. He is survived by three sisters, Mrs. A. W. Sampson of Rochester, N. Y., Mrs. Charles A. Byram of Patten, Me., and a third who lives in California.

He was a member of the American Society of Mechanical Engineers, and of the Engineers and Technology Clubs of New York, and the Engineers Club of Boston. He was a life member of Aberdom Lodge, F. and A. M., and Aleppo Temple, both of Boston.

Mr. Coburn was elected a Member of the American Society of Civil Engineers on March 5th, 1912.

CASSIUS WILLIAM KELLY, M. Am. Soc. C. E.*

DIED DECEMBER 3D, 1918.

Cassius William Kelly, son of John Kelly and Sarah (Sigler) Kelly, was born on May 10th, 1848, in Pleasantville, Pa., where he received his early education. Later, he went to Yale College, and, unaided, worked his way through the Academic Department, and then through the Civil Engineering Course of the Sheffield Scientific School, receiving the degree of Bachelor of Arts in 1870, with a Phi Beta Kappa standing. He received the degree of Bachelor of Philosophy in 1872.

In June, 1872, Mr. Kelly entered the Engineering Department of the City of New Haven, and was connected with that department, in various capacities, for the remainder of his life—a period of forty-six years.

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* Memoir prepared by Henry H. Gladding, M. Am. Soc. C. E.

On January 18th, 1893, he was made City Engineer by the unanimous vote of the Board of Public Works, and served in that capacity until November, 1912, when he was made Consulting Engineer—a position for which he was eminently qualified, not only by his engineering ability, but also by his thorough knowledge of the engineering features and development of the city, and by his familiarity with the intricacies of charter provisions, contract formalities, and the legal technicalities affecting a city's structural growth.

Mr. Kelly's earlier work included a complete trigonometrical survey of the city; determining and establishing street lines and grades; complete charge of paving operations; and the charge of sewer construction during the year preceding his appointment as City Engineer.

In the design of deep masonry foundations for movable bridges he was conservative, and at the same time showed great originality in dealing with the problems involved. His designs for arch bridges of reinforced concrete were well worked out, and the finished bridges are not only adequate but also very satisfactory to the eye.

Mr. Kelly's remarkable memory, keen reasoning powers, and the acknowledged accuracy of his judgment rendered his decisions final and conclusive on many a disputed point.

In his profession, as well as in social intercourse, his absolute integrity and unvarying kindliness gained for him the love and high esteem of all who knew him.

Mr. Kelly is survived by his widow, formerly Frances E. Hart, and two daughters, Miss Miriam F. Kelly and Elsie L., wife of Mr. Grey W. Curtiss.

He was a member, and the Clerk, of the Dwight Place Congregational Church, a member of the New Haven Chamber of Commerce, and the Connecticut Society of Civil Engineers.

Politically, he was a Republican, on general principles, but did not hesitate to exercise an independent discriminating judgment in local issues.

Mr. Kelly was elected a Junior of the American Society of Civil Engineers on March 1st, 1882, and a Member on June 6th, 1888.

ALBERT ALONZO ROBINSON, M. Am. Soc. C. E.*

DIED OCTOBER 7TH, 1918.

Albert Alonzo Robinson was born in the little Village of South Reading, Vt., on October 21st, 1844. He was a son of Ebenezer Robinson, Jr., and Adelaide (Williams) Robinson. For generations his ancestors had been New Englanders. His grandfather, Ebenezer

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* Memoir prepared by J. M. Meade, Esq., Special Engineer, Atchison, Topeka and Santa Fé Railroad, Topeka, Kans.

Robinson, fought in the Revolutionary War. His father, Ebenezer, Jr., was a country school teacher, farmer, and carpenter. He was a mechanic of no mean ability, and the talent he possessed was passed on to his three sons, all of whom have been more than successful in the particular line of engineering in which they embarked. He died in 1848, leaving his wife with a family of four children. Five years after the death of her husband, she married Mr. Albert Childs, and the family moved West, where Mr. Robinson was to stamp the mark of his genius on the country by constructing a great railway system. Although he was held down by the necessity of work and the hardships usually faced by the pioneer Westerners, he received a college education. He attended the Academy at Wilton, Wis., after finishing the common school course, and, later, entered the University of Michigan, from which he received the degrees of Bachelor of Science and Civil Engineer, in 1869. In 1871 his Alma Mater conferred on him the degree of Master of Science, and, in 1900, further honored him with the degree of Doctor of Laws.

Relative to Mr. Robinson's early life: From childhood until he reached his majority he was employed in farm labor, except for a short period when he worked as a clerk in a grocery and dry goods store. While he was a student at the University of Michigan, he was occupied for about 5 months every year as an Assistant Engineer on the United States Lake Survey in astronomical and field work and in the triangulation of the Great Lakes.

His railroad work began in 1869, when he entered the service of the St. Joseph and Denver City Railroad. Mr. Robinson was actively engaged in work with the railroads of the West for a period of 37 years, and rose, by successive promotions, to be Vice-President of the Santa Fé and President of the Mexican Central Railway. It was in April, 1871, that Mr. Robinson entered the service of the Santa Fé, which road was then scarcely 100 miles long. When he left, 22 years later, it had grown into a system of more than 9 000 miles, more than half of which had been built by him.

Mr. Robinson's first work with the Santa Fé was on surveys and construction, between Topeka and Atchison. He was made Chief Engineer in 1873, and, later, held the following positions, in the succession in which they are given: Division Superintendent; Superintendent of Bridges, Buildings, and Water Service; Assistant General Superintendent; General Manager; Second Vice-President; Vice-President and General Manager.

In 1893 he resigned to become President of the Mexican Central Railroad, which position he held until his retirement in 1906, because of his advanced age and the state of his health. While he was President of the Mexican Central, his office was in Boston, Mass. He proved himself a very able administrator, as well as a great engineer, and developed that road into a great railway system. When he went to the Mexican Central, the stock of that company was selling at 5 cents a share and the bonds at 43 cents a share. When he retired, the stock was selling at 50 cents and bonds at 80 cents.

Having built between 5 000 and 6 000 miles of railroad, Mr. Robinson was known as one of the world's greatest civil engineers. The present lines of the Santa Fé Railroad were all constructed under his direction. Coming to the Santa Fé in 1871, he laid out hundreds of miles of that fast-growing railroad. As Chief Engineer, he outlined and executed the vast building, operation, and execution, conceived by Messrs. C. K. Holliday and W. B. Strong. As General Manager, it was his keen judgment that drew hundreds of men to the Santa Fé, and made it the leader of the railroads of the country. He was a leader who was loyal to his men; although twenty years have passed since he was connected with the Santa Fé, his name will go down in the history of that System, as an honest, loyal, staunch friend of his fellow workers.

Mr. Robinson was married in 1869 to Julia Caroline Burdick, of Edgerton, Wis., who died in August, 1881, leaving a daughter, Metta Burdick. On September 2d, 1885, he was married to Mrs. Frances Williams, a sister of his first wife, who, with his daughter and a granddaughter, survives him.

Mr. Robinson was one of Topeka's best known and respected citizens. His residence in that city, since 1875, after a period of nearly 40 years of railroad activity, speaks eloquently of his faith in the city's future and his high esteem of its citizenship. He had always taken a prominent part in local as well as National affairs, and was Past-President of the Topeka Chamber of Commerce, as well as a prominent member of many other local and civic organizations. In politics he was a Republican, and was always connected with the better things associated with the affairs of the city and country.

In 1876 he erected one of the grand residences of Topeka, which is known as one of the beauty spots of Kansas. His home contains one of the greatest collections of art in the West.

Mr. Robinson's death occurred on October 7th, 1918, after months of sickness, which had caused most of his close friends and relatives to lose hope of his recovery.

He was a member of many famous and exclusive civil, technical and social societies, among which were the Topeka Club, the Country Club, the Chicago Club of Chicago, Ill., the Lawyers Club of New York City, and the Jockey and University Clubs of the City of Mexico.

Mr. Robinson was elected a Member of the American Society of Civil Engineers on May 5th, 1880.

ARNOLD HENRY SUTERMEISTER, M. Am. Soc. C. E.*

Died June 30th, 1918.

Arnold Henry Sutermeister was born at Fort Wayne, Ind., on November 16th, 1869. His father, the late Arnold Sutermeister, who was born in Switzerland, was a prominent contractor in the West, having been engaged in business in Fort Wayne, Ind., and Kansas City, Mo. He was a Captain in the Civil War, and commanded the Eleventh Indiana Battery, which command he himself raised at Fort Wayne. This battery shared, to a great extent, in the hottest fighting of the War. Capt. Sutermeister was also with Sherman in his famous march to the sea. Mr. Sutermeister was always very proud of his father's military record.

Mr. Sutermeister spent his early boyhood and received his schooling at Fort Wayne, and, during his early 'teens, went to Kansas City, where he attended High School. J. A. L. Waddell, M. Am. Soc. C. E., a personal friend of his father, was instrumental in sending the young man to Rensselaer Polytechnic Institute. He took the examinations for the Institute in Mr. Waddell's Kansas City office.

He took the civil engineering course at Rensselaer, was graduated in June, 1892, and then entered the service of the United States Geodetic Survey, being engaged as Transitman on the survey of the Hudson River until the fall of that year, when he accepted a position as Assistant Division Engineer on the Mohawk Division of the New York Central and Hudson River Railroad, at Albany, N. Y. He was quickly promoted to Division Engineer of the same Division, and retained that position until July, 1894, when he entered the employ of the Troy Union Railroad, at Troy, first as Roadmaster and then as Superintendent and Engineer, in which capacity he had charge of the design and erection of railroad masonry and bridges.

In July, 1898, Mr. Sutermeister was appointed Engineer in Charge of the Elimination of Grade Crossings for the Board of Railroad Commissioners of New York State, later known as the Public Service Commission, Second District. This position he held until his death, which occurred on June 30th, 1918, at Albany, as the result of an unusual accident in which he sustained a fracture of the skull, due to a blow received when a demountable rim flew from the wheel of his automobile while he was adjusting it. His long service of 20 years as Engineer of Grade Crossings of the Public Service Commission, speaks for the quality of his professional work.

Some of the structures of the grade crossing work, with the design and execution of which he was directly connected, were: the Chenango

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*Memoir prepared by J. W. Pfau, M. Am. Soc. C. E.

Street Viaduct, at Binghamton, over the Erie and Delaware, Lackawanna and Western Railroads; the elevation of the New York Central tracks through Schenectady and through Yonkers; the elimination of the grade crossing at North Pearl and Von Woert Streets on the main line of the New York Central Railroad, in Albany, and also many other grade crossing eliminations throughout the State, from three hundred to four hundred works of this kind having been built during the period in which Mr. Sutermeister served the Commission.

In 1895 Mr. Sutermeister was married to Miss Caroline M. Kreischer, of Albany, who, together with two sons, Arnold, age 19, and Karl, aged 16, survives him. He was a man of pleasing personality and sterling character, and was possessed of particularly sound judgment. His most pronounced characteristic was his sense of fairness. He not only had the desire but also the ability and determination to be fair, a particularly desirable trait for one in the position he held, where engineering decisions had to be made to meet, as nearly as possible, the views and desires of all the various interested parties, namely, adjoining property owners, municipalities, and railroad companies. Mr. Sutermeister was of a modest and retiring disposition, and was a firm believer in the simple life.

He was a member of the University Club of Albany, Sons of Veterans, and the Rensselaer Society of Engineers, and had served as President of the Eastern Division of the Rensselaer Alumni Association.

Mr. Sutermeister was elected a Member of the American Society of Civil Engineers on June 3d, 1902.

EDGAR HAROLD ANNEAR, Assoc. M. Am. Soc. C. E.*

DIED AUGUST 28TH, 1918.

Edgar Harold Annear was born at Ceres, Cal., on December 30th, 1881. He received his early education in the schools of Ceres and Modesto, and pursued a course in civil engineering at the University of California for two years. He then received an appointment to the West Point Military Academy, but was compelled to give it up at the end of a year, because of the prolonged illness of his father.

On returning to California, Mr. Annear was appointed a Deputy United States Land Surveyor, made a survey of Government lands in Monterey County, and, later, engaged in the practice of surveying and irrigation engineering in Stanislaus County, California.

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* Memoir prepared by D. M. McPhetres, Esq.

In 1906, he was elected County Surveyor of Stanislaus County, and was re-elected without opposition in 1910 and again in 1914.

In January, 1918, Mr. Annear resigned his office to take a commission in the Engineer Reserve Corps, U. S. A., and, after three months' training at American University, Washington, D. C., was sent to France in command of Co. B, 43d Regiment of Engineers, U. S. A. He had been promoted to the rank of Major, and had returned to the United States to take back combatant troops, when he was taken suddenly ill, soon after landing at Hoboken, N. J., and died there on August 28th, 1918.

During his term of office as County Surveyor, Mr. Annear was in charge of the planning and construction of a great number of roads and bridges, which were required by the rapid development of the county. He realized the ultimate desirability of permanent and esthetic structures, and the bridges of Stanislaus County are lasting monuments to his genius and constructive ability.

In the latter part of 1916, the people of Stanislaus County voted bonds for the construction of 126 miles of concrete highways. The successful promotion of this project was due, in a large degree, to the untiring effort with which Mr. Annear devoted himself to the education of the people to the necessity and ultimate economy of permanent roads, and, after the bonds were voted, he was placed in direct charge of their planning and construction. With an energy which was characteristic of him, he perfected a highway organization, completed surveys and plans, and succeeded in getting construction under way with such speed that, notwithstanding the ever increasing shortage of labor and material, he was able to see the completion of all but about 18 miles of the system before his resignation in January, 1918. The highways which were built under his direction are conceded to be among the best in the United States.

Capt. Annear was an engineer of the highest integrity and ability. He kept constantly in touch with his work, was possessed of a strong grasp of detail, and the high class of workmanship which is evident in all his work is due largely to his own personal supervision. Under the most trying circumstances, he was always cheerful, was ever ready to overlook the errors of others, and his kindly smile and cheerful greeting made him beloved by his associates and all who knew him.

In July, 1909, he was married to Miss Margaret L. McFarland, who, with a daughter, survives him.

Capt. Annear was elected an Associate Member of the American Society of Civil Engineers on March 5th, 1912.

GEORGE CORLISS SEE, Assoc. M. Am. Soc. C. E.*

DIED AUGUST 28TH, 1918.

George Corliss See, son of James W. and Hester Rose See, was born in Hamilton, Ohio, on June 25th, 1882. He received his preliminary education in the public schools of Hamilton, and was graduated from the Rensselaer Polytechnic Institute in 1905, with the degree of Civil Engineer.

Early in life Mr. See evinced an aptitude for the profession he was to follow. In 1900 he entered the office of his father, Mr. J. W. See, Consulting Engineer, in the capacity of a Draftsman and Designer. Prior to entering the Rensselaer Polytechnic Institute, he was employed as a Rodman by the United States Engineer Department, in Havana, Cuba. Upon graduation Mr. See was employed by the Manhattan Trap Rock Company, at Nyack, N. Y., as Assistant Superintendent, until October, 1905, when he entered the employ of the New York and Long Island Railroad Company. His thorough and painstaking work while connected with the latter company earned for him rapid promotion. In 1906 he had risen from the grade of Rodman to that of Chief of Party. In this capacity Mr. See had charge of the grade and alignment of the Manhattan end of the Belmont Tunnels.

In October, 1906, he became Assistant Engineer of the Fonda, Johnstown and Gloversville Railroad Company. In addition to the duties of general maintenance-of-way work of the road, Mr. See supervised the construction of a four-arch concrete bridge for a grade crossing elimination. He also designed and supervised the construction of many other improvements undertaken by the company during his two years stay with this road.

The last ten years of Mr. See's life were spent in highway work. He was Assistant Engineer and Assistant to the Division Engineer, New York State Highway Department, with headquarters in Albany, from March, 1908, to August, 1917. After his first few years in this service, Mr. See became recognized as one of the foremost highway engineers in his Department. He was entrusted with the supervision of all highway construction in five counties of the Division. In May, 1914, he secured a leave of absence from the State Department of Highways, and, forming a partnership with Harrison Smith, Assoc. M. Am. Soc. C. E., opened an office in Temple, Tex., for the practice of highway engineering. The firm did an extensive business, and it was due to failing health that Mr. See relinquished the field and returned to his former duties in Albany.

In August, 1917, Mr. See was appointed Senior Highway Engineer for the United States Department of Public Roads, with headquarters in Montgomery, Ala. A few weeks prior to his death, he had received orders for transfer from Montgomery to Washington, D. C. While spending a short vacation in Troy, N. Y., before proceeding to his headquarters, he was taken ill, and died the second day following.

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* Memoir prepared by J. C. Watts, Engr., Harbor and Dock Comm., Troy, N. Y.

Besides his wife and son, Mr. See is survived by a host of friends. His genial nature made him loved by all who knew him. His careful, efficient, and painstaking manner made him always a valuable asset to whatever corporation he served. His brilliant and scholarly attainments have made for him a record well worthy of his profession.

Mr. See was a member of Sigma Xi fraternity and of the Rensselaer Society of Engineers. He was elected a Junior of the American Society of Civil Engineers on September 3d, 1907, and an Associate Member on September 2d, 1914.

PAPERS AND DISCUSSIONS CURRENT IN PROCEEDINGS

"Cement Joints for Cast-Iron Water Mains." Clark H. Shaw	Mar.,	1917
Discussion	May, Aug.,	"
Progress Report of the Special Committee to Codify Present Practice on the Bearing Value of Soils for Foundations, etc	Aug.,	"
Discussion	Nov.,	"
Final Report of the Special Committee on Steel Columns and Struts	Dec.,	"
Discussion	Feb., Mar., Apr., Aug., Oct.,	1918
Progress Report of the Special Committee on the Regulation of Water Rights.	Dec.,	1917
Discussion	Feb.,	1918
"Verification of the Bazin Weir Formula by Hydro-Chemical Gaugings." Floyd A. Nagler	Jan.,	"
Discussion	Mar., May, Aug., Nov.,	"
"Determination of the Duty of Water by Analytical Experiment." W. C. Hammatt	Feb.,	"
Discussion	Apr., Oct., Dec.,	"
"The Economics of Steel Arch Bridges." J. A. L. Waddell	Mar..	"
Discussion	May, Aug., Sept., Oct., Nov.,	"
"Construction Methods Used in Building the Lower Reservoir Dam of the Balmorhea Project." Vernon L. Sullivan	Apr..	"
"Improving Arch Action In Arch Dams." L. R. Jorgensen	May,	"
Discussion	Aug., Nov.,	"
Emergency Construction Work Due to War Conditions, With Especial Reference to the Construction Division of the Army." George W. Fuller	May,	"

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Discussion..Apr., Oct., Dec., "

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Discussion...............................May, Aug., Sept., Oct., Nov., "

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"**Improving Arch Action in Arch Dams.**" L. R. JORGENSEN..................May, "
Discussion..Aug., Nov., "

"**Emergency Construction Work Due to War Conditions, With Especial Reference to the Construction Division of the Army.**" GEORGE W. FULLER...May, "

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